

International Atomic Energy Agency
Department of Nuclear Safety and Security

**International Conference
On the
Challenges Faced by
Technical and Scientific Support Organizations
in
Enhancing Nuclear Safety**

23–27 April 2007
Aix-en-Provence, France

Organized by the
International Atomic Energy Agency

Hosted by the
Government of France

CONTRIBUTED PAPERS

IAEA-CN-142

**International Conference on the Challenges Faced by
Technical and Scientific Support Organizations in Enhancing Nuclear Safety**

Aix-en-Provence, France

23–27 April 2007

LIST OF CONTRIBUTED PAPERS

Challenges and Opportunities of the Institute of Radioprotection and Dosimetry in Looking for Environmental Safety Solutions for the Brazilian Private and Public Sectors

(IAEA-CN-142/1)

H.M. Fernandes, M.A. Pires do Rio, D.C. Lauria — Brazil

Role and Responsibilities of Technical Support Division (TSD) of National Nuclear Safety Department (NNSD) in Licensing Process

(IAEA-CN-142/2)

F. Yousefpour — Iran, Islamic Republic of

Recent Tasks and Status of National Research Institute for Radiobiology and Radiohygiene as TSO

(IAEA-CN-142/3)

S. Pellet — Hungary

Technical Support for Nuclear Regulatory Activity and the Italian Experience

(IAEA-CN-142/4)

A. Madonna, F. Perla — Italy

Enhanced Safety Features of CHASHMA NPP UNIT-2 to Encounter Selected Severe Accidents, Various Challenges Involved to Prove the Adequacy of Severe Accidents Prevention/Mitigation Measures and to Write Management Guidelines with One Possible Solution to These Challenges

(IAEA-CN-142/5)

Z. Iqbal, A. Minhaj — Pakistan

Cooperation with the Regulatory Body in the Review Process of Safety Conventions

(IAEA-CN-142/6)

K. Akutagawa — Japan

Sharing Good Practices of Radiation Exposure Reduction in Japan

(IAEA-CN-142/7)

S. Wada — Japan

Perspective of Evolving Needs for Advanced Analysis and Evaluation Methods

(IAEA-CN-142/8)

F. Kasahara, S. Ebata, Y. Otsuka, M. Ogino — Japan

Development of Technical Information Basis of Aging Management for Nuclear Power Plants

(IAEA-CN-142/9)

M. Kanno — Japan

Recent Engineering Support Activities for Establishment of Regulatory Guidelines and Standards Related to the Safety of Radioactive Waste Disposal and Decommissioning

(IAEA-CN-142/10)

H. Kawakami — Japan

Challenges in Introducing Risk Informed Regulation in Japan

(IAEA-CN-142/11)

M. Fukuda, H. Fujimoto, M. Yamashita, M. Sugawara — Japan

Concept of Technical Support Organization for Nuclear Activities in Indonesia

(IAEA-CN-142/12)

A.R. Antariksawan — Indonesia

Role of Technical and Scientific Support Organization in Indonesian Regulatory Body

(IAEA-CN-142/13)

N.A. Yusri Heni, A.S. Zarkasih, Y.P. Liliana, S. Salman — Indonesia

Indian Real Time Online Decision Support System for Offsite Nuclear Emergency

(IAEA-CN-142/14)

*A. Vinod Kumar, R.B. Oza, P. Chaudhury, M. Suri, S. Saindane, K.D. Singh,
P. Bhargava, V.K. Sharma — India*

CNWRA Assistance to U.S. Nuclear Regulatory Commission: Contributions to Regulatory Science

(IAEA-CN-142/15)

B. Sagar, W.C. Patrick — United States of America

New Frontiers for the Nuclear Safety Analysis and TSO's Challenges

(IAEA-CN-142/16)

T. Hamidouche — Algeria

Support for the Inspection System Improvement for the Nuclear Power Plants

(IAEA-CN-142/17)

M. Kobayashi — Japan

Towards Establishment of European Clearinghouse on Operational Experience Feedback

(IAEA-CN-142/18)

V. Ranguelova, M. Bieth — European Commission

LANL's Offsite Source Recovery Project as a Tool to Handle Unwanted/ Disused Radioactive Sources

(IAEA-CN-142/19)

G.I. Balatsky, W.R. Severe — United States of America

Radionuclide Migration at Sites of Temporary Storage of SNF and RW in North-West Russia — Contribution to Regulatory Development

(IAEA-CN-142/20)

*M.K. Sneve^a, N.K. Shandala^b, G.M. Smith^c, E.I. Orlova^b, I.M. Barraclough^c, A.V. Titov^b,
O.A. Kochetkov^b — Norway^a, Russian Federation^b, United Kingdom^c*

Probabilistic Safety Analysis of Nuclear Fuel Cycle Facilities in the Russian Federation

(IAEA-CN-142/22)

T.Y. Bogdanova, B.G. Gordon, S.V. Tsvetkov, R.B. Sharafoutdinov — Russian Federation

Experience Feedback from Incidents: Methodological and Cultural Aspects

(IAEA-CN-142/23)

R. Perinet — France

The Building of a Pluralist Expertise Group about Uranium Mines in Limousin (France)

(IAEA-CN-142/24)

D. Gay — France

Openness to Civil Society: The Challenges for the TSOs

(IAEA-CN-142/25)

M. Petitfrère, F. Rollinger — France

IRSN and the Period Safety Reviews Related the Ten-Yearly Outages of French Nuclear Power Plants

(IAEA-CN-142/26)

M. Le Carrer — France

How to Evaluate the Effectiveness of Safety Assessment in the Area of Human Factors?

(IAEA-CN-142/27)

G. Rolina, J.C. Moisdon, F. Jeffroy — France

RIA and LOCA Safety Criteria

(IAEA-CN-142/28)

IRSN/DSR/ST3C — France

The IRSN Experience Feedback for the Transport Package Design Safety Appraisals

(IAEA-CN-142/29)

G. Sert — France

Addressing Communications between Regulatory Body and TSO: Perceptions and Problems

(IAEA-CN-142/30)

I. P. Salati de Almeida — Brazil

Cooperation of Russian and EU Technical Support Organizations

(IAEA-CN-142/31)

M.V. Kuznetsov, V.I. Kozlov, E. Yu. Kapralov — Russian Federation

Technical and Scientific Support to Nuclear Regulatory Authority in Montenegro: Present Situation and Outlooks for the Future

(IAEA-CN-142/32)

S. Jovanovic — Montenegro

Promoting Safety Culture in Radiation Industry through Radiation Audit

(IAEA-CN-142/33)

M.A. Noriah — Malaysia

Neutron Detector Based on Nuclear-Optical Converter

(IAEA-CN-142/34)

V.V. Gorbunov, L.E. Dovbysh, S.P. Melnikov, A.V. Sinitsyn, A.A. Sinyanskii — Russian Federation

Development of Training Simulator Based on Critical Assemblies Test Bench

(IAEA-CN-142/35)

A.T. Narozhnyi, S.V. Vorontsov, O.A. Golubeva, A.M. Dyudyaev, V.I. Il'in, M.I. Kuvshinov, A.V. Panin, D.P. Peshekhonov — Russian Federation

Process of Upgrading the Radiation Protection Services in R. Macedonia

(IAEA-CN-142/36)

L. Nikolovska — The Former Yugoslav Republic of Macedonia

Current Status of the Regulations of the Nuclear Activities and Activities Involving Ionising Radiation Sources in the Republic of Moldova

(IAEA-CN-142/37)

A. Buzdugan — Republic of Moldova

Technical and Scientific Support of Nuclear Power Development in Belarus

(IAEA-CN-142/38)

A. Mikhalevich — Belarus

Technical Support Organization of Armenian Nuclear Regulatory Authority: Establishment, Development and Current Status

(IAEA-CN-142/39)

A M. Amirjanyan — Armenia

Benefits of Research Activities Incorporation into the Core Business of Smaller TSOs

(IAEA-CN-142/40)

J. Rovny — Slovakia

Upgrading Nuclear Safety and Security Infrastructure in Yemen

(IAEA-CN-142/41)

M.Y. Bahran — Yemen

System for TSOs to Support NRA Decision Making

(IAEA-CN-142/42)

S. Tzotchev, N. Vlahov — Bulgaria

Place of Technical Support Organizations in Nuclear Energy Development

(IAEA-CN-142/43)

K. Lubomirova — Bulgaria

Towards Optimal Use of Available Technical Resources for Regulatory Purposes: The Syrian Experience

(IAEA-CN-142/44)

R. Shweikani, H. Suman, I. Othman — Syrian Arab Republic

Enhancing Security at the Mexican Nuclear Research Center

(IAEA-CN-142/45)

M. Ballesteros, H. Rico — Mexico

Radiation Protection and the Role of TSOs in Kenya

(IAEA-CN-142/46)

J.A.W. Maina — Kenya

Serving the Industry to Improve Nuclear Power Operational Performance

(IAEA-CN-142/47)

S. Li, J. Cheng — China

Italian Military Response to Nuclear Safety

(IAEA-CN-142/48)

A. Mugnai Poggesi — Italy

The Evolution of the Role of the Philippine Nuclear Research Institute in the National Nuclear and Radiation Safety Regime

(IAEA-CN-142/49)

A.M. Dela Rosa — Philippines

The Role of CNEA as a TSO in Enhancing Nuclear Safety

(IAEA-CN-142/50)

C.J. Gho — Argentina

The Role of the CNEA Like Organization of Scientific and Technological Support to Accentuate the Nuclear Security

(IAEA-CN-142/51)

M.A. Bisauta — Argentina

The Establishment and Practices of TSOs for Chinese Nuclear Regulatory Body

(IAEA-CN-142/52)

HAO Xiaofeng — China

Role of Technical Support Activities for Enhancing Design and Operational Safety of Nuclear Plants

(IAEA-CN-142/53)

U.L. Sharma, P.V. Varde — India

Conference of Radiation Control Program Directors — A Model for Networking, Cooperation, Resource Sharing, Information Exchange and Regulation Harmonization

(IAEA-CN-142/54)

T.P. O'Kelley — United States of America

Technical Support of Regulatory Authority in Ukraine

(IAEA-CN-142/55)

V. Inyushev, O. Mayboroda, L. Yermakova, O. Zeleny — Ukraine

Technical Support Organization of National Regulators: Challenges and Strategy

(IAEA-CN-142/56)

S.A. Mallick, N. Maqbul, S. Kanwal and J.A. Hashmi — Pakistan

CHALLENGES AND OPPORTUNITIES OF THE INSTITUTE OF RADIOPROTECTION AND DOSIMETRY IN LOOKING FOR ENVIRONMENTAL SAFETY SOLUTIONS FOR THE BRAZILIAN PRIVATE AND PUBLIC SECTORS

Fernandes HM, Pires do Rio MA, Lauria, DC
Instituto de Radioproteção e Dosimetria (IRD/CNEN)
Av. Salavador Allende s/nº CEP 22780-160 Recreio
Rio de Janeiro Brazil

Abstract. The Institute of Radiation Protection and Dosimetry (IRD), from the Brazilian Nuclear Energy Commission (CNEN), holds a singular position in the nuclear energy and radiation protection areas in Brazil. It develops applied researches to support the licensing and control of nuclear and radioactive installations in the country with the aim to protect members of the public, workers and patients against the undesirable effects of ionizing radiation. Doing so, the IRD contributes to the safe development and implementation of nuclear technologies in Brazil. One of the values of the IRD is to keep track of the state of art methodologies and researches in the different areas related to radiation protection, dosimetry and metrology upgrading its expertise to support the regulator during the licensing process and to discuss with the operator adequate safety solutions to solve any potential relevant radiological issue. Training of professionals of the nuclear area, by means of on-going regular courses graduate academic courses is also in the scope of IRD activities. In this context the IRD promotes discussions to spotlight the research trends and demands of the private and public sectors in those fields. This paper summarizes the most relevant issues on the perspectives of environmental radiation protection and radioecology in Brazil. The elements in this paper come from a workshop that was organized by the IRD and sponsored by CNEN and by the Brazilian National Council of Research and Technology (CNPq) that took place in Rio de Janeiro in November of 2004. It is expected that the products of this workshop will give the scientific and technical communities elements to help in the development of their research aligned with the needs of the country in these areas. In terms of the institute perspective the challenge that was pointed out during the workshop and to be faced by the institution was to find appropriate means to connect all its activities in a logical framework in order to find the adequate synergism between research and regulatory activities, that allow IRD to give support to the decision making process in the nuclear licensing process and to assist its stakeholders in a growing demand scenario, avoiding conflict of interest.

1 Introduction

Radiation protection is needed in a variety of activities, including nuclear fuel cycle installations, nuclear energy generation, materials science and technology, medicine and the handling of materials containing natural occurring radioactive materials (NORM). The backdrop in a developing country like Brazil is the growing energy demand that can be satisfied by nuclear energy with the bonus of avoiding greenhouse gas generation. This in turn leads to increasing mining and milling of uranium ores and production of materials in the nuclear fuel cycle [1]. In line with many comparable countries, Brazil is a major producer of raw materials that have natural radioactivity associated with them (e.g. NORM-industries) In this context, a major task is to raise full awareness in the governmental sector and in the society as a whole to implement adequate protection measures.

In order to give adequate level of protection to members of the public and workers licensing and control activities must be put and place and must be based on the state-of-the-art standards and regulatory documents. Therefore, in Brazil, the Brazilian Nuclear Energy Commission (CNEN), the regulatory authority, is in charge to provide standards for radiation protection and nuclear safety. The CNEN standards are based on the recommendations of the International Committee on Radiological

Protection (ICRP) and are consistent with the International Atomic Energy Agency (IAEA) standards, particularly the IAEA Basic Safety Standards.

The Institute of Radiation Protection and Dosimetry, IRD, which is part of CNEN and has the task to perform safety assessments and inspections to evaluate the compliance of nuclear installations with the Brazilian regulations. It must be noted however, that regulatory activities do not consist of a simple compliance assessment of regulations by the operators. Regarding environmental issues, for example, it is also necessary that several natural mechanisms, relevant to the transport of radionuclides into the environment, be evaluated. In order to achieve a convenient understanding of these processes, mathematical models may be needed along with the sampling and analysis of environmental samples. It is very common to say that a multidisciplinary approach is needed to be put in place when one deals with the assessment of environmental impacts caused by nuclear installations. Thus, different researches are being carried out at IRD, concerning mathematical modeling of reactive geochemical transport of radionuclides from different types of wastes; transfer of radionuclides in the food chain after accidental releases as well as investigations on the behavior of artificial and natural radionuclides in terrestrial and freshwater systems. Increasing the knowledge on radiation safety provides the scientific bases for giving support to the decision making process in nuclear licensing.

The objective of this paper is to present the most relevant issues that has been discussed during staff internal and external participants workshop's on the scope of Environmental Radiation Protection and Radioecology aiming to give the scientific and technical communities elements to subsidize the development of their research aligned with the needs of the country in these areas [2] [3].

2 Main discussed issues

Regarding the safe operation of nuclear installations, it was made clear that the adoption of certified environmental management systems (EMS) might help the nuclear installations to achieve higher standards of environmental performance as well as to improve the relationship with regulatory organisms. It is a challenge to IRD to stimulate all nuclear installations to adopt environmental/quality management systems. However, the IRD has to commit itself in following the same path. It can be said that a proper quality management system (quality assurance / quality control) will be very helpful in cases where government decisions or the results of scientific investigations on which they may be based are challenged in court. Though not assuring quality in themselves, the implementation of relevant ISO standards, as for example, is a step into the right direction.

Finding out concrete solutions for the final deposition of low and high level radioactive wastes is one of the most relevant challenges to be faced by the Brazilian society. There are no current radioactive waste repositories in Brazil, and the nation has deferred decisions on this subject until they can be addressed in the future when more knowledge and international guidance is available. In the meantime, most radioactive wastes are stockpiled or disposed of *on-site* where they are generated. Besides, knowledge with NORM waste management will also be useful in the context of developing safety cases for near-surface repositories for low-level radioactive waste, and *vice versa*. Building on the plethora of worldwide research results, specific aspects for tropical Brazil could be developed. High rainfall rates for example will pose a significant challenge to any cover design. The long-term behavior of engineered repositories and also of remediation sites needs to be carefully assessed for the given climatic and geomorphological conditions in Brazil.

The major radioecological problems in Brazil are obviously connected with mining activities of both uranium and other ores. During extraction of ores, radioactivity may be concentrated in the tailings from which it may be dispersed by wind and water to the atmosphere and to freshwater bodies. The extraction process influences the speciation and may enhance the potential mobility in the environment. Mining is an activity of relevant economical importance to Brazil more or less countrywide spread. The amounts of radioactive material may be high. Their fate and speciation in the environment is the result of a complex processes. In the light of the vast international experience, some studies targeted on crops and soils specific to Brazil may be warranted. Similarly, the migration

behavior of selected radionuclides under conditions specific to Brazil might also need some attention. Then the objective should be to continue and to incentive the radioecological and modeling researches in the scope of natural radionuclide behavior as well as to promote studies related to management of low-level long-lived wastes. In addition, the knowledge of the natural radionuclide background in the country as a whole, considering the different geological formations and complementing the existing survey is a matter of primary importance and a big challenge considering the size of the country and the available finance resources. The gathering of all available data in a georeferenced database and the radio vulnerability mapping are valuable tools in this respect.

Regarding (TE)NORM industries the IRD can play a key role in aiding the non-nuclear industries in identifying radiological risks and to introduce them to best mitigation practices as well as impact assessment protocols. For workplace exposures, such mitigation measures can often be very simple and do not interfere with the industries competitiveness. In other cases, particularly when it comes to the safe disposal of large volumes of residues, more serious challenges arise that may need to be addressed on a national level. It also needs to be recognized that while large raw materials companies, often with a multi-national background, would have the financial and means and knowledge to implement mitigation measures, this may not be the case for the smaller mining companies. Research into their needs and suitable mitigation measures might be warranted. The actual exposures and associated risks are quite variable from industry to industry and from site to site. Given the Brazilian setting, the first effort should be to prioritize the potential problems. This could also include historical residues, though for them less resource might be available. Given the limited resources available, careful cost-benefit analyses could be the first step to be undertaken. Besides, means of communicating experiences that can potentially reduce environmental risk of NORM processes and operations should be provided.

All issues connected with radioactivity cause anxiety and public concern. To overcome this problem, recently activities started to initiate dialogues with stakeholders to broaden the acceptance of the nuclear industry. The dialogue shall start in a very early stage of projects. The aim is to provide transparency of the intentions of the nuclear industry and to increase confidence. The process of confidence building is often slow and difficult; there is always a risk of rebounds. In some situations it may be the case that public perception may drive processes much more than scientific insight. Certain researches may need to be undertaken to satisfy public concerns, though it might not be *a priori* of priority from a scientific perspective. Collaboration with outside institutions, *e.g.* universities, may enhance public trust. Anyway, educational needs for the public concerning radiation are a significant matter, especially when local authorities may request interventions. With respect to (TE)NORM use of radioactivity contaminated wastes for home construction, and construction of houses on radioactively contaminated lands may take place. As a result guidance on educating the public in such matters is very important. As a result, some emphasis shall be put in providing better education to the public on radiation issues, including avoiding misuse of TENORM.

3 Conclusions

The future of nuclear energy will depend to a large extent, among other things, on the ability of the sector to prove the society that nuclear energy is safe. Also, non-nuclear industries may face some problems when their activities may be related to radiological issues. In order to overcome this challenges all the players shall share same values and pursue common objectives. It is well known that regulators and operators must preserve an adequate degree of independence from each other in such a way that unethical behaviors are avoided. On the other hand, there is a need for a constant dialogue, experience exchange and cooperation as both sides also share a common responsibility, that is to say, the improvement of the Brazilian society well-being. The IRD, as a Technical and Scientific Support Organization (TSO) can adequately make this link.

The workshop mentioned in this text was a key element to help the institution to develop an action-plan to build up an agenda that can foster the development of activities to structure the IRD as a TSO. The main topics that would have to be addressed, as conclusions to this text are:

- Aiding in the efforts oriented to estimate the volumes of current and future radioactive wastes that may need isolation and ultimate disposal, and what may be necessary to identify and ultimately approve potential waste repositories.
- Regarding NORM-industries, research shall be developed to know their needs for radiation protection standards and suitable mitigation measures for occupational safety and environmental protection.
- Contribute to determine what is an acceptable radiation dose or risk for a member of the public resulting from exposure to a source of radiation. This is essential for remediation of contaminated sites, and for ongoing industrial activities.
- Stimulating the adoption of certified environmental management systems by nuclear installations in a way to lead them to achieve even higher standards of environmental performance and improving their relationship with regulatory organizations.
- In countries like Brazil in which the indoor exposure to radon is not conveniently assessed, a national policy should be taken in a step-by-step manner from characterization of the problem to implementation of appropriate remedial actions whenever necessary.
- Accordingly, different types of pilot studies should be carried out to identify potential sources of elevated radon exposure, detailed national surveys should be initiated, and in particular, a national risk management strategy should be defined taking into account the results of other international studies.
- Development and establishment of support systems to make both nuclear and radiological emergency responses more rapid and efficient.
- Finally, educational needs for the public concerning radiation are a significant matter, especially when interventions may be requested by local authorities. Consequently, guidance on educating the public in such matters is very important. As a result, some emphasis shall be placed on providing better education to the public on radiation issues, particularly avoiding misuse of (TE)NORM wastes for building materials, or construction of residential housing on (TE)NORM contaminated lands.

REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY (2001). Analysis of Uranium Supply to 2050. Vienna, 103 pp.
- [2] International Workshop on the Perspectives of Environmental Radiation Protection and Radioecology in Brazil (2004). Technical Report, November 16 – 19, Institute of Radiation Protection and Dosimetry, Rio de Janeiro (in Portuguese).
- [3] H.M. Fernandes & M.A. Pires do Rio (2005). Perspectives of Environmental Radioecological Studies in Brazil. *In: 7TH MEETING ON NUCLEAR APPLICATIONS (VII ENAN)*, Santos/SP, August 28 - September 02, 2005.

Role and responsibilities of Technical Support Division (TSD) of National Nuclear Safety Department (NNSD) in licensing process

F. Yousefpour
National Nuclear Safety Department
Iranian Nuclear Regulatory Authority
Atomic Energy organization of Iran
Tehran/Iran

Abstract. National Nuclear Safety Department is authorized by INRA (Iranian Nuclear Regulatory Authority) for issuing rules and regulation and conducting the licensing and supervisory process for nuclear facilities. The main responsibilities of the NNSD are conducted via five main division are, nuclear codes and standards, Nuclear Safety assessment, Authorization, Inspection & Enforcement and Technical Support. In this paper, the functions and responsibilities of TSD in enhancing nuclear safety are described. Examples of main tasks to support the Nuclear Safety assessment division regarding to technical calculations and research of safety issues in licensing documents are provided.

1. Introduction

Utilization of Nuclear facilities such as Nuclear Power Plants (NPPs), research reactors and fuel cycle like other advanced technologies have potential hazard for public, operating personnel and the environment. Comparison of this hazard with other conventional facilities shows that nuclear facilities have caused comparatively less damage to the public. One of the reasons of low risk of nuclear facilities is considering safety of these facility as a first priority. The nuclear facilities are designed and constructed with many provision in order to prevent the occurrences of accident in the first phase and the mitigation of probable consequences and damages in the second phase.

Design and construction of nuclear facilities up to an international level in any member state of IAEA require observation of specific number safety criteria, codes and standards and continuous supervision over all activities in all stages including sitting, design, construction, commissioning, operation and decommissioning of nuclear facilities. Safety assurance of NPPs and other nuclear facilities, minimizing their potential risks and also assurance of the existence of sufficient protections for personnel, public and the environment necessitate establishment of nuclear regulatory body based on international criteria and regulations.

On the basis of general policy of the Islamic republic of Iran, Iranian Nuclear Regulatory Authority (INRA) is authorized for regulatory control of Nuclear Facilities and radiation safety.

2. Structure of National Nuclear Safety Department

The regulatory functions of INRA for all Nuclear facilities including, NPPs, research facilities, Fuel cycle Facilities, waste disposal and Nuclear material transportation are performed by NNSD which is structural part of the INRA.

The organization chart of NNSD is shown in Fig 1, The main responsibilities of the NNSD are conducted via the following five divisions:

- Nuclear Safety Assessment
- Establishment of Regulation, Codes & Standards
- Inspection & Enforcement
- Authorization
- Technical Support

Division of Nuclear Safety Assessment is responsible for the assessment and evaluation of various submitted technical and safety documents in a number of areas including, siting, design of safety system and components, quality assurance, technical specification and environment during design, construction, commissioning and operation of nuclear facilities.

These information must be submitted by designer, manufacture and operator of nuclear facilities upon which licenses and permits will be issued.

Divisions of Establishment of Regulation, Codes & Standards is responsible for development of codes and standards in the fields of siting, Emergency planning & preparedness, Radiation protection & waste management, quality assurance and etc.

Regulatory inspection and quality assurance of equipment during manufacturing, erection, commissioning and performance of different tests will be accomplished by independent inspectors.

Division of Inspection & Enforcement is responsible for fulfillment of its assignments in the following fields.

- Siting
- Design
- Construction & manufacturing
- Commissioning, operation & decommissioning
- Fuel transportation & handling
- Local inspection (projects site)

Division of Authorization is responsible for issuance the license for specified activities such as siting, construction commissioning and operation after approval of the licensing committee. This division performs contractors qualification registration stage of nuclear projects issuing permits for subcontractors involved in different activities in construction and commissioning and also.

Technical Support Division has the responsibility to provide technical support for regulatory activities of NNDS. The division has also the task of coordination of the on going research & development activities on nuclear safety being conducted inside and outside the department.

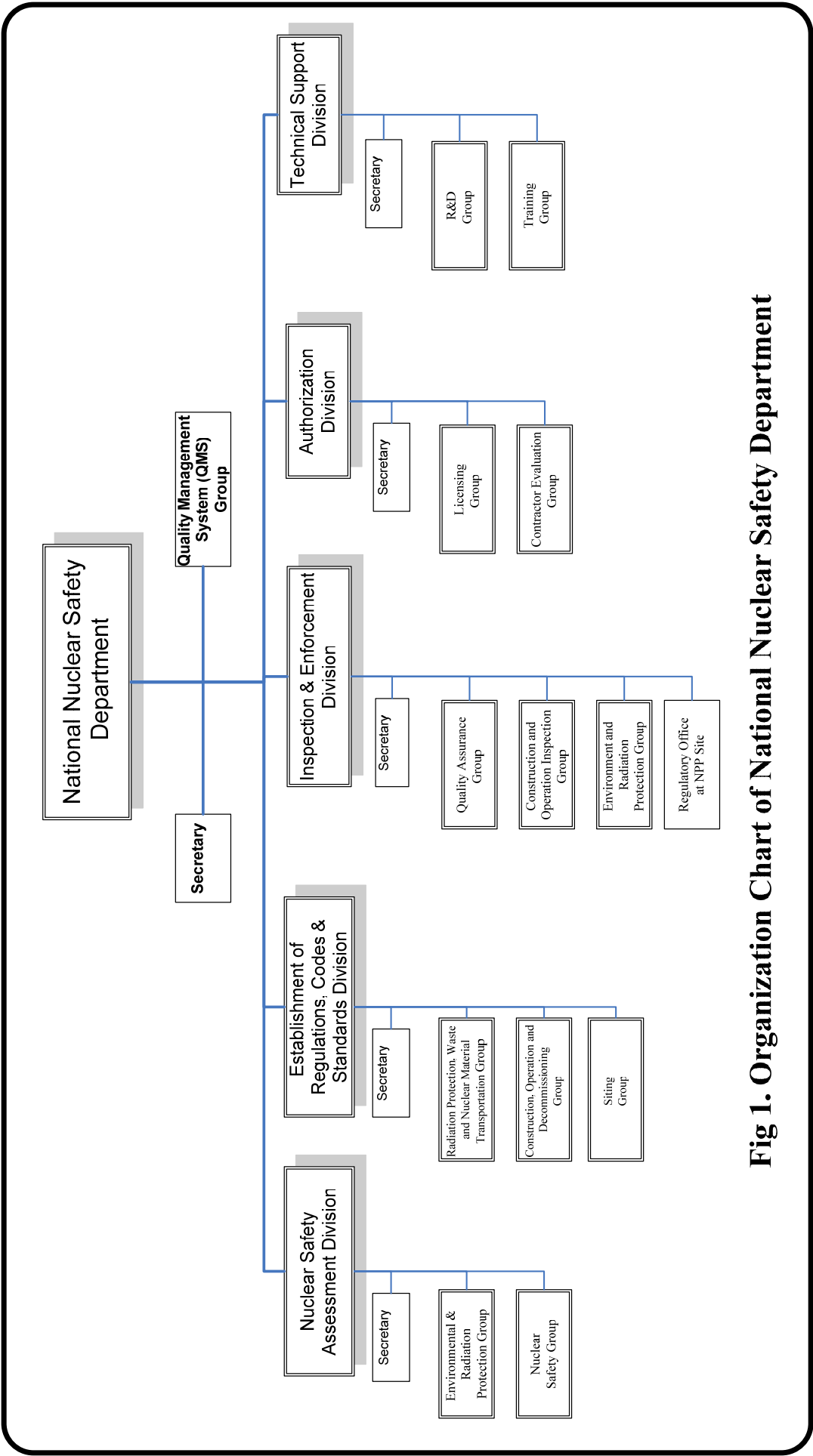


Fig 1. Organization Chart of National Nuclear Safety Department

3. Role and responsibilities of Technical Support Division

As, it is shown in Fig 1, The Technical Support Division consist of two main Group which are Training and R&D Group. Competence of regulatory staff is one of the pre requisites for the safety of nuclear facilities. Every regulatory body shall ensure that the proper skills and adequate levels of competencies are exist and maintained in his organization. In order to implement the requirement, the regulatory body needs to implement a group to follow the training needs for regulatory staff and implement the training program. In the NNSD the training group of TSD has this responsibility. The main functions and responsibility of training groups of TSD are as follows:

- Development of comprehensive training program for NNSD personnel
- Implementation the training program for newcomers and NNSD staff
- Maintaining the expert qualification with development of on-going training program
- Supervision on applicants training program for operating personnel of Nuclear Facilities such as NPPs, Research Reactors and etc.
- Supervision and surveillance on examination of operating personnel at Training Centers

Regulatory research comprises of activities related to research and development and analysis, that are necessary towards obtaining deeper insights into safety issues and finally for helping to regulatory decisions.

Regulatory research has a wide area of application and is connected with at most every aspect of regulation of nuclear facilities since it provides the appreciate scientific basis for regulatory decisions, it removes or minimizes the element of subjectivity in the decision making process and there by improves the effectiveness of regulatory bodies. The decisions arrived at in this manner are reasonable and defendable.

Research and development group as a main Group of TSD conducts the following support activities:

- Development of the computer code for safety analysis and technical calculation
- Analysis of nuclear accidents
- Re evaluation of analyses performed by applicant in submitted justification documents
- Cooperation with research institute and universities
- Nuclear safety assessment (Assessment of PAS documents submitted by applicants)

In the next section, examples of tasks performed by the groups are mentioned.

4. Examples of tasks performed by Technical support division

4.1. Reevaluation of Analyses Performed By Applicant

To support nuclear assessment division of NNSD, Technical support Division performs various analyses to evaluate correctness of information presented in safety analysis report of the facility. Examples of analyses are as follows:

Seismic Analysis of Major Components

Seismic analysis of major facility components (e.g. Class 1 components) is performed according to accepted national and international codes and standards using validated computer software. For this purpose, the head of division arranges two teams of different experts

containing thermohydraulic experts, mechanical experts, and civil experts. The first team reviews the seismic characteristics of the site, the facility and the components and prepares input information for the next team. The second team performs seismic analysis typically by using finite element method.

Leak Before Break Evaluation of Major High Energy Pipelines

General Design Criteria 4 (GDC-4) of Appendix A to 10 CFR Part 50 allows the use of analyses reviewed and approved by the commission to eliminate from the design basis the dynamic effects of the pipe ruptures postulated in the standard review plan [ref to NUREG-0800].

When an applicant requests to eliminate dynamic effects of a pipe rupture from the design basis of a nuclear power plant, the division head arranges a team of fracture mechanic experts to perform individual evaluation of leak before break applicability to the requested pipeline. The team performs leak before break analysis on the pipeline by aid of SIAP (Structural Integrity Assessment Program) code developed and verified by the NNSD experts. The division head reports results of evaluation to safety assessment division for appropriate actions.

4.2. Development of Engineering Software

Another duty of the research and development group of TSD is to develop engineering software required to increase accuracy and simplify (for the staffs) the documents assessment. To accomplish the delegate duty, the research and development division has developed engineering software for fracture analysis of flawed structures. The SIAP (Structural Integrity Assessment Program) program is developed in cooperation with Amirkabir University of Technology. The program uses ASME XI, and R6 Option 1 to evaluate maximum allowable flaw in a structure. In addition, two important modules for fatigue and stress corrosion cracking life estimations are available in the program.

4.3. Cooperation with Research Institutes and Universities

In order to use state-of-the-art knowledge in assessment of nuclear facilities, this division has different cooperation with research institutes and universities. Some the achieved results regarding this cooperation are as follows:

- (a) Development of SIAP software
- (b) Survey on leak before break analysis methods
- (c) Survey on risk based inspection methods in nuclear power plants
- (d) Comparison between western and Russian codes regarding fracture mechanics analysis of nuclear power plants

5. Conclusions

Technical support division of NNSD as a part of the regulatory body performs his duties for improving safety and supporting the other division. It has a significant role in Licensing/Regulatory process of nuclear facilities in Iran. This division helps to nuclear safety assessment division for proving the accuracy of submitted information by nuclear facilities applicant in licensing documents. It also helps to other divisions by development and implementation of training program for NNSD staff and as results preparing qualified experts in all area of regulatory functions.

Recent tasks and status of National Research Institute for Radiobiology and Radiohygiene as TSO

Dr. Sándor Pellet

"Frédéric Joliot-Curie" National Research Institute for Radiobiology and Radiohygiene
Budapest, Hungary

Abstract. The technical support function of the National Research Institute for Radiobiology and Radiohygiene has been introduced at the time of its establishment. In order to support the actual requirements the Institute carries on extended research in the fields of radiation protection and radiation biology participating in national and international projects. Supporting the proper performance of national radiation protection and safety tasks the Institute gives professional directives and expert opinions for decision processes of authorities. The Institute's main areas of radiation protection activity are:

- Radiation-related licensing, inspection, record keeping,
- assuring safety of radiation sources,
- National Personal Dosimetry Service,
- radiological monitoring of the environment,
- preparedness for radiological incidents and accidents,
- radiation protection training activities.

The Institute has an accredited Testing Laboratory with nearly sixty examination protocols. Together with its Central Environmental Testing Laboratory, the Institute thus provides a significant support for both theoretical and practical accomplishment of the national radiation protection and safety tasks.

1 History of the Institute

Upon a governmental decision in 1954, the Institute was finally founded by the Ministry of Health as *Central Research Institute for Radiobiology* on January 1, 1957. The primary task was to "study the radiation-induced diseases and their healing that could arise in the course of peaceful utilisation of nuclear energy or its use for military purposes, and through an extensive application of radioactive isotopes".

The Institute was rebaptised to "*Frédéric Joliot-Curie*" *Central Research Institute for Radiobiology* in 1959. Mainly due the launch of the domestic nuclear energy programme, the sphere of tasks of the Institute continued to expand. National coordination and implementation of research in radiohygiene, workplace and environmental radiohygiene sectors and research and development of radioactive therapeutic preparations have been introduced. In the interests of performing the newer tasks and clarifying the profile of public health institutes, the Departments of Radiation Hygiene of the National Institute for Occupational Medicine; Radiation Physics of the National Institute of Roentgen and Radiation Physics and the Radiation Hygiene Laboratory of the National Institute of Public Health were attached to the Institute. The Institute thus expanded was renamed in 1963 "*Frédéric Joliot-Curie*" *National Research Institute for Radiobiology and Radiohygiene* (NRIRR). The Institute's three actual Departments: Radiation Biology, Radiation Hygiene, and Application of Radiation and Isotopes were established in 1974. In 1984 the Postgraduate Medical School has established a Chair of Radiation Hygiene at the basis of the Institute. On January 1, 1998, the NRIRR became a part of the "*Fodor József*" *National Centre for Public Health* (NCPH).

2 The Institute's position in the structure of national radiation protection and safety organizations

The following four harmonized regulations cover the radiation protection and safety requirements in Hungary:

- *"Decree No. 16/2000. of the Minister of Health"* on the Execution of Act on Atomic Energy; which lays down the basis of radiation protection in accordance with the recommendations of ICRP 60 and IAEA SS No. 115;
- *"Decree No. 47/2003. of the Minister of Health, Social and Family Affairs"*, which in final clauses modifies the structure of radiological health organization;
- *"Governmental Decree No. 124/1997"* on Radioactive Materials and Devices Generating Ionizing Radiation Exempted from the Scope of Act on Atomic Energy;
- *"Decree of the Minister of Public Welfare No. 23/1997"* on the Exemption Levels of Activity Concentrations and Activities of Radionuclides.

FIG. 1 illustrates the general structure of radiation protection and safety system belonging to the Ministry of Health. The top level organisation is the Ministry of Health itself as regulatory authority and coordinating organization towards the government. The main public health authority, the National Public Health and Medical Officer Service (NPHMOS) is the top level actor supervising and controlling execution of actual operative tasks.

FIG. 1. Structure of the radiological health system in Hungary

The network of NPHMOS consists of:

- seven *"Radiological Centers (RCs)"* as the first instance regional authorities, and
- the *"Office of the Chief Medical Officer (OCMO)"* as the second instance authority.

The NRIRR is the basic expert institute and advisory body for the authority network of NPHMOS and for the Ministry of Health. One of the special tasks of the NRIRR is the harmonization of activities of competent radiohygiene authorities (e.g. by production of appropriate codes, manuals, trainings etc.) The regional competence is divided among seven RCs providing radiohygiene tasks of the NRIRR.

FIG 2. Regional radiological protection centres (RCs)

3 Participation in assuring safety of radiation sources

3.1 Licensing

According to the *"Decree No. 16/2000. (VI. 8.) of the Minister of Health"*, all activities related to radioactive substances are subject to licensing. The RCs or the OCMO are responsible for the licensing procedures supported by expert opinions of NRIRR in special cases.

OCMO gives the licenses for the licensing of the manufacture, production and distribution of radioactive materials and other exceptional cases using expert opinion of NRIRR.

3.2 Inspection

For the request of an RC the supporting NRIRR participates in the inspection procedures.

3.3 Record keeping

The RCs keep record of licences in own regional competence. The records contain data about the users, the used equipment, the used sealed and unsealed radioactive sources and about persons. In NRIRR a National Registry of Radiation Workplaces (NRRW) is in operation, which is updated monthly. One of the main purposes of NRRW is to provide status reports for the requests of the authorities.

CATEGORY	TYPE OF WORK UNITS	FREQUENCY
EXTRA	Nuclear power plant	1 insp. / year
	Training and research reactor	
	Radioactive waste disposal facility	
	"A" type radioisotope laboratories	
	Spent fuel interim storage facility	
I.	Tele- and brachytherapy	1 insp. / year
	Medical accelerators, irradiators	
	Industrial accelerators, irradiators	
	Radioactive waste management	
II.	Medical and industrial X-ray	1 insp. / 5 year
	Radioisotope storage and handling	
III.	Dental X-ray	1 insp. / 5 year
	Industrial gauging	

Table I. Frequencies of the inspections depending on the categories of working units

4 Support of environmental monitoring

4.1 RAMDAN

The first initiation to establish "*Radiological Monitoring and Data Acquisition Network*" (RAMDAN) was in 1975. Its primary aim was to monitor the environment to detect any kind of artificial radioactive isotopes produced by nuclear weapon tests. To satisfy this requirement, Ministry of Health issued its Order No. 8/2002 (III.21.) to define the aims and goals of RAMDAN to cover both routine radiological monitoring of the environment and dose estimation of population based on a general concept of public health. The tasks of the central institution of RAMDAN were addressed to NRIRR, covering the following main tasks:

- development of sampling methods and radiological measurement techniques for both normal and nuclear emergency cases,
- running an environmental monitoring program,
- preparation the Annual Sampling and Measurement Programme of RAMDAN,
- providing scientific and technical support of countryside laboratories,
- determination of the annual dose received by the Hungarian population from the different sources of ionizing irradiation being in the environment,
- periodical reporting and publishing the results of the work program of the RAMDAN.

The central environmental laboratory in NRIRR coordinates and directs the work of environmental laboratories of RCs.

4.2 NERMS

According to the Decree No. 275/2002 (XII.21.) of the Government, the "*National Environmental Radiological Monitoring System*" (NERMS) was established to determine the radiation burden of the population due to artificial and natural radioactive sources and qualify the general environmental radiation situation by collecting and analysing the relevant environmental monitoring results. The central acquisition and processing of radiological

measurements performed by the Information Centre of the NERMS is established and operated by NRIRR.

5 Centralized Personal Dosimetry

NRIRR operates the National Service for Personal Dosimetry (NSPD). This Service supplies all the workplaces applying any kind of ionising radiation in the country with film dosimeters, according to the "*Order No. 16/2000 of Ministry of Health*".

Table II. Number of persons involved in personal dosimetry in 2005.

Area of application	No. of workers	Average annual external dose per person (mSv)
Nuclear energy production and research	4576	0.48
Medical applications	9948	0.11
Industrial applications	1428	0.45
Research, education	370	0.02
Natural sources	19	5.5

6 Preparedness for nuclear and radiological incidents and accidents

6.1 Participating and organization of nuclear emergency exercises

NRIRR is also involved in the national and international nuclear emergency exercises regularly. Especially; in 2005, NRIRR had tasks in the preparation and organizing works of the exercise "INEX-3 (2005) HUN". The main goal of this exercise was to examine the readiness of the decision making systems of Hungarian authorities and in a regional scale radiological incident, including the intermediate and late phase of the emergency situation (as the scenario of the emergency was extended in several months in a simulated time scale, the exercise was split in two calendar days).

6.2 National Radiation Hygiene Preparedness Service (NRHPS)

On basis of the NRIRR, the NRHPS is responsible for the management of radiological incidents and accidents supporting the tasks of various authorities including safety, defence and anti-terrorist actions.

6.3 Preparation of treatment of radiation injured persons

NRIRR has been designated by the World Health Organization in October 2004 as a WHO Collaborating Centre for Radiation Emergency Medical Preparedness and Radiation Health, especially within the WHO Radiation Emergency Medical Preparedness and Assistance Network (WHO/REMPAN).

7 Support of radiation protection trainings

Since 1988, NRIRR regularly organizes radiation protection training courses. This training system is regulated by the Decree No. 16/2000 of the Minister of Health, and is based on three levels: low, medium and extended level courses. NRIRR participates in licensing procedures of other trainings, too. NRIRR provides trainings for IAEA fellows and scientific visitors at the aspects of radiation protection in occupational and medical exposures, safety of radioactive waste management, radiation technologies, research-development of diagnostic and therapeutic radiopharmaceuticals, protection and research of non-ionizing radiation exposures, and radiation emergency medicine.

8 Scientific activities

The indispensable basis of the Institute's expert and organisator role in national and international radiobiological and radiohygiene tasks lies in its extensive research activities. A rather wide spectrum of scientific activities is present. In 2005 only, the Institute was involved in 29 national projects while 17 programs were running jointly with the EC, the IAEA and WHO or performed by international bilateral co-operations.

**International Conference on the Challenges faced by Technical and Scientific Support
Organizations in Enhancing Nuclear Safety**

**April 23-27, 2007
Aix-en-Provence, France**

Topical Issue 1: Roles, functions and value of TSOs

<http://www-pub.iaea.org/MTCD/Meetings/PDFplus/>

Technical support for nuclear regulatory activity and the Italian experience

A. Madonna (APAT) - F. Perla (ITER-Consult)

Abstract

Different cases exist in various countries regarding the institutional status, the organization and the technical resources of the Nuclear Regulatory Authority (NRA): there are NRAs having extended internal technical capability and others relying mostly on external technical support.

Considering the research and development activities and the very broad range of technical matters on which the regulatory and licensing activity are based, the NRA can not rely only on internal resources, and generally there is the need of technical and scientific support together with enhanced international cooperation.

The international cooperation and networking among NRAs, and their Technical Support Organizations (TSO), represents a fundamental way to maintain competence, capability and knowledge. Within the EU member states this is becoming more and more an institutional duty.

In providing technical support for regulatory activity, the experience shows, from one side, the importance to have TSO with recognized competence, capability, independence and appropriate regulatory view, and from the other side, the importance to have within NRAs well developed and experienced technical management capability, in particular to address and use the results of the external technical support.

Since its creation the NRA of Italy took care to develop within the organization high level of competences to face the different technical aspects concerning the safety of nuclear installation without the support of any official-institutional TSO. Nevertheless external support from national and international organizations, and experts, has been provided depending on specific needs.

A few years ago a group of senior experts in nuclear and radiation safety, some of them with previous working experience in the Italian Nuclear Regulatory Authority, took the initiative to create an expert organization (ITER-Consult Ltd) non-commercial, with the main objective to maintain qualified expertise and safety culture in Italy and make it available to NRA and to the EU Institutions.

This organization is going through the process, and the challenge, to achieve operational stability maintaining the non-commercial attitude.

Introduction - Need for independent technical support in regulatory and research activities related to nuclear and radiation safety exists and has shown to become more and more important in the present time to ensure the fully coverage of the today's regulatory role.

It is normally provided by state or private expert organizations which are called Technical Safety Organization (TSO). The wording TSO fully developed at the beginning of nineties when the assistance cooperation programs with central and eastern European countries were initiated.

In some countries full scope technical support is provided to the regulatory authority for licensing and regulatory activity. In other countries the need for support is identified case by case and it is provided by selected organization.

Regulatory Activity – The role of the nuclear regulatory authority is well defined in the national law for peaceful use of atomic energy of each country. Institutional independence, capability and adequate resources are necessary requirements for an effective NRA. Different situations exist in various countries regarding the institutional status, the organization and the technical resources of the NRA.

In terms of role and functions the NRA covers many aspects including among others:

- the regulatory activity related to definition of safety objectives, principles and criteria issuing regulations and regulatory guidelines;
- the licensing activity related to safety evaluation of design, construction and operation of nuclear installation,
- the inspection and enforcement during construction and operation of nuclear installation

The NRA generally can not face all the aspects related to its role and function with only internal resources: the need for technical and scientific support becomes important, also considering the development of the international cooperation in all areas of concern to put together resources and experience for common programs and harmonize the regulatory approaches.

The Nuclear Regulatory Authority of Italy (now Agenzia per la Protezione dell'Ambiente e Servizi Tecnici - APAT), has been established since the years fifties and has covered its role very effectively since the very beginning.

It has promoted and developed high level of competences to face the different technical aspects concerning the safety of nuclear installation and significantly contributed to the international cooperation. In its historical development has based its licensing decision process mainly on the evaluation performed by its own internal technical staff. Therefore no official-institutional TSO support has been created. Nevertheless external support for research, studies and technical evaluation has been provided depending on specific needs by external organizations including national and foreigner research institutes, universities and consulting organizations.

The current institutional activities relate to the control for nuclear and radiation safety for NPP under decommissioning, research reactors, transport of radioactive materials, waste management, the obligations deriving from international conventions/treaties and the international cooperation.

In addition to the current national regulatory duties the today objective of the regulatory authority aims also to maintain the regulatory capability in the perspective of a potential reconsideration in Italy of the nuclear energy option, and share the EU responsibility and initiatives in the field.

The issue of nuclear and radiation safety in the EU is presently subject of common initiatives and common approaches involving all member states and implying the effective contribution and the sharing of responsibility from all NRAs.

APAT in coherence with its institutional role participates since 1992 in multilateral and bilateral programs of assistance - cooperation with eastern European countries promoting clear definition and interpretation of different roles, strengthening regulatory regime, transferring western methodology, approaches and tools for licensing and regulatory activity.

So far in Italy does not exist any institutional TSO, and the support from external organization, when needed, has to be identified and activated through an administrative process the implementation of which implies relevant formal difficulties.

The experience gained in the latest years indicates the importance for the NRA to rely on flexible procedures, or agreements, which allow fast and prompt activation of the needed technical support avoiding uncertainties and delays that can challenge the schedule of activities or the commitments being taken.

Technical Support to NRA – The technical support to NRA is relevant and systematic in some countries and less relevant in other countries depending on the historical conception and development of the NRA and its internal organization and resources.

Resource limitation, organizational aspects, increased scope of national and international activities, optimisation of use of internal resources are aspects that contribute to generate the need for support from external organization. The technical support for licensing activities, is particularly important as its conclusions form the main basis for the regulatory decisions.

The experience shows that the effectiveness of a NRA in its regulatory function and dialog with the operators remain in the capability to address and use the results of the technical evaluation. This indicates that NRA needs well developed and experienced management of the technical support with respect to regulatory process to which it refers.

In countries where the TSO function is quite institutional, the technical support is provided by ad hoc organizations, non-commercial, fully dedicated to the role of technical support. They are funded through state budget or through stable yearly contractual budget from the administration of the NRA.

The independence of the support, and so far of the TSO, represents a key aspect to avoid potential conflicts.

The requirements of independence of the organization providing the support becomes more and more stringent the more extensive is the scope of the support with respect to the overall technical evaluation to be performed.

The experience shows that the organizations normally providing their services for technical assessment in support of third parties are those having the knowledge and the approach corresponding to the regulatory view and therefore their support fully and effectively meet the needs of the regulator.

Therefore the non-commercial attitude of expert organizations represents a value not only for the prevention of potential conflict but also for the development of the most appropriate view and approach in providing their services.

From the technical point of view the technical support is effective if well defined in terms of inputs, of scope and expected outputs and clearly focused on the objective.

Therefore the NRA has to develop and maintain high level capability for management of interfaces with the TSO support.

The technical management capability, in parallel with the primary responsibility to coordinate the interface and maintain an effective dialog with the Operator remains the key competence and responsibility of the NRA together with the decision process based on the technical support and other regulatory aspects.

The cooperation and networking among TSOs at an international level represents more and more a necessity for maintaining competence, to optimise the resources, to improve knowledge, to get acquainted with different approaches, to benefit from the experience coming from other organizations. The issue of ensuring nuclear safety is, by definition, an international issue. In this aim the cooperation promoted by international organizations/institutions like IAEA, WENRA, OECD, is expected to increase and to address the evolutionary process related to regulation of nuclear and radiation safety.

In Italy in June 2003 the initiative was taken by a group of senior experts, previously working in the Italian Nuclear Regulatory Authority, to create an expert organization ITER-Consult, having the legal status of a Private Limited Company (Ltd.), with the main objective to maintain qualified and updated expertise and safety culture in Italy and make it available to the Nuclear Regulatory Authority (NRA) and to the institutions of the European Union in support of their activities in the field of nuclear and radiation safety, being therefore at the service of national and international community.

The creation of this organization represents a serious and responsible initiative making available a resource capable to ensure technical support, maintain safety culture and knowledge, transfer motivation and know how. Independent technical evaluation and technical support has been provided since the beginning in activities concerning nuclear and radiation safety for Italian institutions and EU programs.

Requirements and challenges in providing technical support - The need for qualified independent technical support, well finalized under an appropriate regulatory view, represents a clear demand today in all developed countries. The role and quality of technical and scientific expertise in the regulatory systems are of fundamental importance.

Vision, values and strategy are essential elements to address independent technical support for regulatory authority activity.

The approach for effective implementation of the support activity needs to make reference to clear objectives, clear understanding of roles and responsibilities of the involved parties, well implemented technical management and effective implementation of quality system.

The capability to provide the support for licensing activities relies on experience, well trained experts, knowledge of regulatory requirements, knowledge of national and international approaches, knowledge of roles and responsibility of the regulator from one side and of the operator from the other side.

The TSO, as expert organization, has to ensure the development and the maintenance of technical knowledge and competence. In this respect, interaction and cooperation between TSOs needs to be promoted and strengthened at national and international level. The international cooperation constitutes a basic pillar in the field and the expert organizations needs to be effectively involved in the initiatives promoted by international organizations.

The technical support for regulatory activity is normally provided under non-profit policy of the organization. A private initiative in this field does not represent an exception, effective and motivated organization allow to address and resolve in the required time schedule and restraints issues (technical and administrative) that are normally much more complicated in large state funded organizations.

The funding stability for a private organization providing independent non-commercial technical support needs to be achieved in order to ensure the required competence and the stated independence.

Regarding ITER-Consult in Italy, the competence, experience and technical capability of the organization is recognized through the activities performed and the results achieved. The cooperation with national and international institutions and organizations has been established since the very beginning of the activity. The process, and the challenge, to achieve operational stability is in progress and it represents not an easy task to tackle, given the commitment to retain independence (and consequent non-commercial attitude) of the organization.

ACKNOWLEDGEMENTS

We would like to express our gratitude to Mr. G. Santarossa and Mr. G. Trenta for their contribution in the preparation of the paper.

Authors

A. Madonna - Head of external cooperation unit of APAT Nuclear Department

F. Perla - General Manager of ITER-Consult

Enhanced safety features of CHASHMA NPP UNIT-2 to encounter selected severe accidents, various challenges involved to prove the adequacy of severe accidents prevention/mitigation measures and to write management guidelines with one possible solution to these challenges.

Zafar Iqbal, Azfar Minhaj

Pakistan Atomic Energy Commission, Chashma Nuclear Power Plant Unit-2, Pakistan.

Abstract. This paper describes enhanced safety features of Chashma Nuclear Power Plant Unit-2 (C-2), a 325 MWe PWR to encounter selected severe accidents and discusses various challenges involved to prove the adequacy of severe accidents encountering measures and to write severe accident management guidelines (SAMGs) in compliance with the recently introduced national regulations based on the new IAEA nuclear safety standards. C-2 is being built by China National Nuclear Corporation (CNNC) for Pakistan Atomic Energy Commission (PAEC). Its twin, Unit-1 (C-1) also a 325 MWe PWR, was commissioned in 2000. Nuclear power safety with reference to severe accidents should be treated as a global issue and therefore the developed countries should include the people of developing countries in nuclear power industry's various severe accidents based research and development programs. The implementation of this idea may also deliver few other useful and mutually beneficial byproducts.

1. INTRODUCTION

Pakistan and China have been co-operating for a long time in the area of peaceful uses of nuclear energy. China National Nuclear Corporation (CNNC) has already constructed a 325 MWe Pressurized Water Reactor (PWR) for Pakistan. The plant, Chashma Nuclear Power Plant Unit-1 or C-1, is located at Chashma site. C-1, which was commissioned in 2000, has now been in operation for about four years.

Prior to this, there was only one nuclear power plant operating in Pakistan, the 137 MWe KANUPP, a CANDU type Pressurized Heavy Water Reactor, supplied by Canada. For almost all of its design life, KANUPP received no vendor support because technical assistance in the area of nuclear technology was denied to Pakistan. However, KANUPP was operated safely for 30 years by PAEC. Upon completion of its design life in 2002, KANUPP carried out many safety retrofits and has been allowed by PNRA to operate at a reduced power – pending additional retrofits required to complete the licensing process for life extension.

To carry out the licensing process of the first unit, Chinese nuclear regulatory authority, National Nuclear Safety Administration (NNSA), cooperated with the nuclear licensing authority of Pakistan which was called the Directorate of Nuclear Safety and Radiation Protection (DNSRP). At that time, DNSRP operated under the auspices of Pakistan Atomic Energy Commission which owned the plant. NNSA provided the necessary consultancy.

The site for C-1 was selected in the early seventies. The first site report, completed in 1984, was for a 900 MWe NPP of French design. However, after signing the contract for the 325 MWe NPP with CNNC, a new site evaluation report was prepared. Both site reports were prepared as per the format and content of Chapter 2 of the PSAR according to the USNRC RG 1.70 (Rev. 3). The safety review

was carried out according to the Agency's standards and the USNRC Standard Review Plan (NUREG-800).

The C-1 PSAR, prepared with the assistance of the Chinese vendor and designer, was submitted in 1992. Again, the format and content of USNRC RG 1.70 (Rev. 3) were followed due to unavailability of such guidance from IAEA. During the early period of negotiations for the supply of C-1, the regulatory requirements in China were based on IAEA 50 C-D-Rev. 0, whereas in Pakistan the regulatory requirements were based on the later version, Rev. 1. The Chinese vendor maintained that sufficient guidelines were not available to fully implement the Agency's requirements. However, after several discussions, consensus was reached on an acceptable solution regarding application of the revision in C-1 design.

The safety analysis reports were reviewed primarily by using the NUREG-800. However, during the review process, DNSRP supported by NNSA and the Chinese designer ensured that IAEA Guide's intent was generally fulfilled by the design and the safety analysis reports. The industrial standards used were mostly of US origin but Chinese standards were also used. The basic design was also reviewed by an expert team organized by IAEA. The review result was positive.

Since the Chashma site was planned and developed for twin units, some structures and buildings were built to accommodate two units. When the work on C-1 started, negotiations were held between CNNC and PAEC for the second unit, C-2. However, no deal could materialize at that time because the economic situation in Pakistan did not allow another major investment in nuclear power without knowing the final outcome of the first exercise. The successful commissioning and operation of C-1 paved the way for the second unit. Dialogue was reinitiated with CNNC who showed their willingness to supply the second unit but similar in design to the first unit.

In the mean time, an independent licensing body, Pakistan Nuclear Regulatory Authority (PNRA) came into existence in Pakistan. The regulation issued by PNRA in 2002 on the design of NPPs, is based on the IAEA NS-R-1 document. The IAEA standard was relatively new and more demanding, and the lower tier guidelines did not provide adequate information necessary for fully implementing the requirements of these standard. By that time NNSA had not adopted the new IAEA standard. Because of the uncertainties in the implementation of the regulation, the Chinese designer and vendor found it difficult to enter into a commercial contract guaranteeing licensability on the basis of the regulation. This led to difficulties in finalizing the technical details around which the contract could be written. An effort was made to invite PNRA to the technical negotiations with the vendor, but PNRA found it difficult to get involved as no formal submission had been made to them.

The C-2 Contract was ultimately signed by making such design changes in the C-1 design as would meet the intent of the new national regulation according to the understanding of the vendor and the buyer. The practical experience of full compliance to the regulation does not exist in China, Pakistan or elsewhere. Therefore, the licensing process of C-2 will be a challenging exercise and an example of the application of the new IAEA standards based regulation to the existing design.

C-2 design is upgraded on the basis of Qinshan-1 and C-1 experience/feed back. Based on international experience, engineering judgment; analysis of a selected set of severe accident sequences was conducted. On the basis of this analysis, the measures were incorporated in C-2 design in the form of enhanced safety features. Like many other nuclear power plants of the world, the challenging job of in-depth analysis to verify the adequacy of measures against severe accidents is yet to be done. Furthermore, severe accident management guidelines (SAMGs) to control and mitigate the consequences of severe accidents are also yet to be drafted, analyzed, verified and validated.

2. ENHANCED SAFETY FEATURES OF C-2 DESIGN

The approach adopted by CNNC and PAEC was to take C-1 as a reference plant, review the design, and make modifications based on the new requirements. As a result of a two-year effort, it was agreed between the two parties that the C-2 design would include the following:

Zafar Iqbal

- (1) Incorporation of more than 170 design changes on the basis of feed back from Qinshan-1 and C-1;
- (2) Installation of Loose Part Monitoring System in the Primary circuit;
- (3) Use of Probabilistic Safety Analysis to check and balance the plant design with respect to safety;
- (4) Severe accident analysis leading to the design of preventive and mitigation measures and preparation of Severe Accident Management Guidelines (SAMGs);
- (5) Specific measures for the prevention and mitigation of a selected set of Severe Accident sequences based on international experience, engineering judgment and the result of the above analysis. Typically, the list would include the following:
 - (a) Large Break LOCA with High Pressure Injection/Low Pressure Injection failure (during safety injection phase)
 - (b) Large Break LOCA with High Pressure Injection/Low Pressure Injection failure (during safety injection recirculation phase)
 - (c) Small Break LOCA with High Pressure Injection/Low Pressure Injection failure (during safety injection phase)
 - (d) Small Break LOCA with High Pressure Injection/Low Pressure Injection failure (during safety injection recirculation phase)
 - (e) Loss of Off-site Power with Auxiliary Feed Water failure
 - (f) Steam Generator Tube Rupture with High Pressure Injection and Feed Water failure
- (6) Upgrading the Control Room to meet the requirements of human factor engineering;
- (7) Safety System Bypass and Inoperable Status Indication System in Control Room; and
- (8) Commitment of the designer to follow the principles of defense in depth and ALARA in the design.

Table 1. **Comparison of C-2 with other Two-Loop PWRs**

Plant Characteristic	ANGRA-1[1] Brazil	Calvert Cliffs[2] USA	Qinshan-1[3] China	C-2[4] Pakistan
Power (MW _{th})	1876	2570	966	998
No. of Steam Generators	2	2	2	2
Pressurizer Volume (m ³)	28.3	42.5	35.0	35.0
Containment Type	Reinforced Concrete	Reinforced Concrete	Pre-Stressed Concrete	Pre-Stressed Concrete
Containment Volume (m ³)	39,600	56,633	49000	49000
Containment Volume/Power	21.1	22.0	50.7	49.0
Containment Design Pressure (psig)	41.4 (2.8 bar)	50 (3.4 bar)	38.22 (2.6 bar)	38.22 (2.6 bar)
Containment Design Pressure/Power	0.0221	0.0195	0.039	0.038
Containment Basemat Thickness (m)	-	3.048	3.0	5.4

Table 2. Comparison of C-2 Accident Mitigation Countermeasures with those in other PWRs with Large Dry Containment

Plant Characteristic	Surry ^[5] USA	Robinson ^[5] USA	Beznau ^[5] Switzerland	Biblis-B ^[5] Germany	Tsuruga-2 ^[5] Japan	C-2 ^[4] Pakistan	Remarks
Power (MW _{th})	2441	2300	1130	3750	3441	998	-
Containment type	Reinforced Concrete	Reinforced Concrete	Steel	Steel	Pre-stressed Concrete	Pre-Stressed Concrete	Indicates load capacity, leak tightness
Containment Volume (m ³)	51000	59400	36400	70000	73300	49000	Containment loads, Time scale of accident time budget for Accident Mitigation
Containment Volume / Power	20.83	25.64	32.25	18.51	21.73	49.10	-
Fuel mass (kg)	79000	78900	43500	-	89500	40746	-
Containment Volume / fuel mass	0.65	0.75	0.84	-	0.82	1.20	Indicates Containment loads from Direct Containment Heating (DCH)
Zirconium mass(kg)	16500	16335	12000	29750	19500	10767	-
H ₂ -mass (kg), with 100% Zr-oxidation	780	718	530	1350	855	472	Zr+H ₂ O= ZrO ₂ +2H ₂ +Heat
Average H ₂ -concentration (%) at 30°C, dry, 100% Zr-oxidation	15.0	12.1	12.8	19.0	12.4	8.1	Potential for H ₂ burn, Containment loads from H ₂ burn. Density of hydrogen calculated at design pressure of containment i.e. 2.6 bar
Estimated pressure (bar) due to H ₂ burn, 100% Zr-oxidation	9.4	7.6	7.9	11.7	6.7	4.7	Heat of reaction (18°C) = 241750 kJ/kmol K ^[6]
Containment spray	Yes	Yes	Yes	No	Yes	Yes	Yes

Plant Characteristic	Surry ^[5] USA	Robinson ^[5] USA	Beznau ^[5] Switzerland	Bilibis-B ^[5] Germany	Tsuruga-2 ^[5] Japan	C-2 ^[4] Pakistan	Remarks
Hydrogen control	-	-	Containment venting	Igniters/ Recombiner	Combination of recombiners and inertisation of atmosphere	Passive auto-catalytic recombiners and/or igniters	Reduces potential for hydrogen burn
Additional water injection to inside of containment	-	-	External from the fire truck: *backup water source for containment spray *Flooding of containment External from river for cooling of fan coolers	-	Under preparation: water injection from RWST and fire water system	*Provision of connection to outer sources at the suction of containment spray pump *Reactor cavity water injection system for cooling of RPV lower head under severe accident	External vessel cooling for core debris and late containment failure by over-pressurization
Depressurization of RCS for prevention of High Pressure Melt Ejection (HPME), ("primary side bleed")	Transient with loss of all FW	Transients with loss of all FW	Transients SLOCA with loss of all FW	Most events with loss of all FW	Most events with loss of all FW	Most events with loss of all FW with the help of POV/MTV	Reduces chances of DCH.
Estimated containment failure pressure (bar)	9.7	10.4	7.8	8.0	-	6.5	For C-2, it is calculated as 2.5 times the design pressure.
Containment failure pressure/ Power	0.6467	0.8595	0.6094	0.4211	-	0.8025	-
Use of Primary Bleed/Feed in the event of SGTR	-	-	Yes	-	Yes	Yes, by Pilot Operated Valves (POV) /Motor Throttle Valves (MTV)	To reduce release attending SGTR
Filling of SG with water in the event of SGTR	-	-	Yes	Under study	-	Under study	To reduce release attending SGTR

3. A RELATIVE EVALUATION OF THESE ENHANCED SAFETY ASPECTS

The design of C-2 is in essence based on C-1, which was based on Qinshan-1. The design philosophy of Qinshan-1 was similar to the Westinghouse type plants and the safe operation of Qinshan-1 for more than ten years has demonstrated the safety and reliability of the Chinese design. Thus, the vendor has gained sufficient experience on a design which was robust to begin with. Because of the successful Q-1 and C-1 experiences, and because of the safety enhancement features added to the C-1 design which already has large safety margins built into it, the design of C-2 will now be as safe as or even better than most of the PWR type nuclear power plants operating in the world.

Table-1 compares some inherent safety features of C-2 with some of the older two-loop PWRs which are still in operation. The enhanced system capacities (containment volume, basemat thickness) tend to increase the safety margins allowing the plant a better chance to cope with accidents. Use of PSA to balance the plant design will further result in the enhancement of plant safety. Sufficient PSA experience already exists with the PAEC because full power Level-1 PSA has already been carried out for its Karachi Nuclear Power Plant and that of C-1 is almost ready. A Pre-IPSART mission is likely to be invited next year to review the C-1 PSA.

In the area of Severe Accidents (SA), emphasis has been given to all three aspects, i.e., prevention and detection of accidents and mitigation of accident consequences.

The following measures will be taken in C-2 to prevent severe accident:

- (1) Motor Throttle Valve (MTV) will be used in addition to power operated valves and safety valves of the Pressurizer during normal and abnormal conditions. In addition, this valve will also be used to depressurize the primary system to allow emergency coolant injection to the primary system in case of accident;
- (2) The anti-dilution mechanism or interlocks will be implemented during conditions of reactor cold shutdown and Reactor Coolant Pumps tripped; and
- (3) In addition to two Emergency Diesel Generators on independent trains, one diverse Non-1E diesel generator will be provided to withstand the events of Station Black-Out (SBO) which may lead to the seal LOCA conditions

To increase the accident detection capability, the following specific measures will be taken:

- (1) Provision of wide range hydrogen concentration monitoring system
- (2) Provision of instruments with their limiting capability to meet the SA environment

Several steps will be taken to mitigate the consequence of severe accident and to reduce the challenge to the containment integrity. These include:

- (1) Primary System depressurization with Motor Throttle Valve to prevent high pressure melt ejection
- (2) Reactor Cavity Cooling Water Injection system
- (3) Passive Hydrogen Recombination Facilities

Containment is the final barrier to the release of radioactivity to the environment. Concerted efforts will be made to prevent this release by strengthening the containment boundary including the penetrations, namely:

- Equipments hatch
- Personnel airlock
- Fuel transfer compartment
- Process penetrations

- Electric penetrations
- Isolation valves inside the containment
- Sleeve of gate valves of containment recirculation sump
- Ventilation valves of the containment
- Isolation valves of fire protection for the containment

Event sequences that may result in a containment by-pass will also be taken care of by:

- (1) Quick primary depressurization with Motor Throttle Valve in case of Steam Generator Tube Rupture; and
- (2) Increase in the design pressure of Residual Heat Removal System piping.

In addition, PAEC and CNNC have entered into a contract to jointly develop the severe accident management guidelines.

Table-2 compares plant/containment design characteristics and provisions for accident detection/prevention/mitigation measures in C-2 with some of the operating PWRs with Large Dry Containment.

However, the effort to keep the plant safe is a continuing process and does not end with a safe design. PAEC, as the owner of the plant, is committed to take measures to ensure safe operation of the plant. Such measures would include personnel training, development of a safety culture and an effective surveillance program. A continuing process of dialogue between the regulators and the utility has also been set up and this will greatly help in the accomplishment of the safety goals.

4. VARIOUS CHALLENGES INVOLVED TO PROVE THE ADEQUACY OF MEASURES AGAINST SA AND TO WRITE SAMGs AND ONE POSSIBLE SOLUTION

Pakistan is not a vendor country nor does it have much experience with the design of nuclear power plants. Besides C-1, which has been operating for about 4 years, PAEC's nuclear experience in the field of managing nuclear power plants over the last 30 years has been limited to essentially one NPP which is basically a first generation PHWR – the Karachi Nuclear Power Plant. When this plant was designed and built forty years ago, there were very few safety requirements and the relevant expertise (both at the national and the at the international level) with reference to analyze and combat the severe accident scenarios did exist.

TMI and Chernobyl's severe accidents leave a strong message that nuclear power safety with reference to severe accidents is a global issue and older safety beliefs, concepts and practices should be replaced with some more safe and secure safety culture. Therefore, now we should believe that nuclear power safety with reference to severe accidents is no more regional issue and people must join hands to save the world from the threats and consequences of severe accidents. The abandoning of hydrocarbons with consistent price hike has given birth to the revival of nuclear energy. Nuclear energy is thought to be the one of the best alternative sources of energy for underdeveloped countries like Pakistan having limited number of other options.

Nuclear power industry's various severe accident based phenomena's like hydrogen production/combustion rate are yet to be completely known. Therefore, a serious challenge does exist to confirm the adequacy of various encountering measures against severe accidents. A live and iterative research/technical collaborations among the nuclear power producing countries can provide an appropriate solution to such challenges.

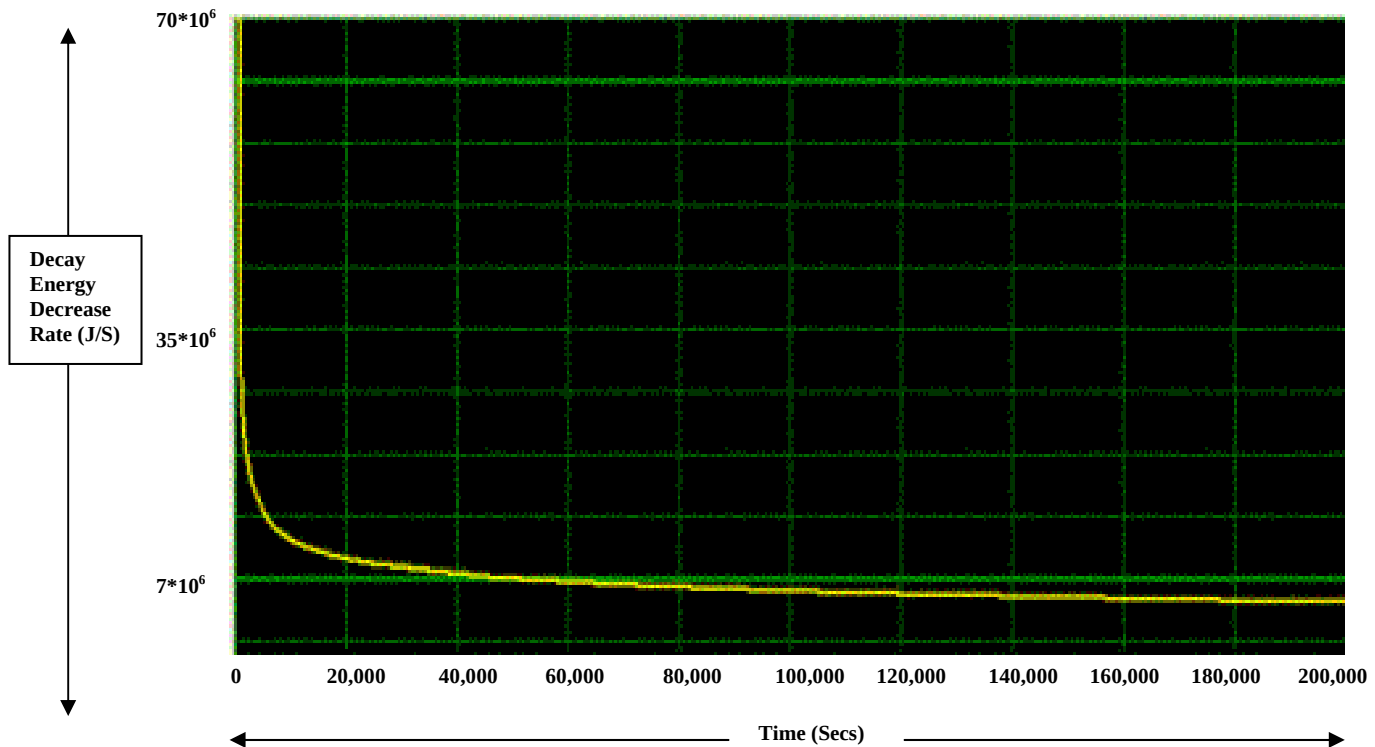
For example, reactor containment is considered as the ultimate safety barrier or last radioactive confinement option. Therefore, we would like to check and confirm the adequacy of containment heat removal system to save the reactor containment in case of severe accident.

Assuming a worst severe accident scenario; when significant core meltdown occurs, shutdown rods shut the reactor under gravity, a complete external/internal power failure makes the ECCS and heat exchangers unavailable for a postulated period of 2×10^5 Secs. We supposed to ensure the in-vessel retention of molten fuel through removing the plant decay heat inside containment through borated water feed and bleed using the water of accumulators (35.4 m^3 each) and refueling water storage tank (RWST, 1995 m^3) under gravity (C-2 RWST design heat load is 4.675×10^6 Joules/Sec). We Suppose to continue with this until ECCS and heat exchangers become available (after 2×10^5 Secs). Proceeding sections contain the conservative based rough estimate of total energy added into the C-2 containment.

As C-2 core is about 1000 MWt; therefore in-vessel retention is the most significant and effective severe accident controlling and consequences mitigating measure/job required to be completed appropriately as well as adequately. C-2 containment free volume is about $49,000 \text{ m}^3$ and design pressure is 2.6 bar (2.6×10^5 pascals per square meter). Therefore, up to (maximum) 12.74×10^9 joules energy can be safely stored inside the C-2 containment.

Decay heat is the heat produced by the decay of radioactive fission products after a nuclear reactor has been shut down. Decay heat is the principal reason of safety concern in Light Water Reactors (LWR). It is the source of 60% of radioactive release risk worldwide. The amount of decay heat that will be present in the reactor immediately following shutdown will be roughly 7% of the power level that the reactor operated at prior shutdown. Decay heat exponentially decreases and it may decrease to about 2% of the pre-shutdown power level within the first hour after shutdown and to 1% within the first day. Failing to cool the reactor after shutdown results in core heatup and possibly core meltdown (i.e. Three Mile Island 2). Emergency Core Cooling Systems (ECCS) and heat exchangers achieve decay heat removal. These highly redundant systems are designed to provide sufficient amount of makeup water for several days without operator intervention

Immediately after shutdown (at time = 0 sec), 7% of the total 1000 MWt was present in the C-2 core in form of decay heat, and then it exponentially decreases as per following graph (Ref-8).



Initial (at time 0 sec) energy addition rate (power) into C-2 containment = 70×10^6 Joules per sec (70 MW); Then it exponentially decreases as per above graph upto 2×10^5 Secs. The conservative based total energy added into containment (the area under curve) = 1400×10^9 Joules. This mean containment heat removal system with design capacity $\geq 7 \times 10^6$ joules/sec or in general ≥ 0.7 % of the core thermal power will be adequate to save the reactor containment.

The significant thing is that without inclusion of hydrogen factor (hydrogen production/combustion rate) no one shall accept/validate this calculation. Worldwide research is yet underway to completely understand the hydrogen factor/phenomena and the severe accident analysis tools are also under-development and validation stage. Therefore serious challenges do exist to verify the adequacy of severe accidents encountering measures like the in-vessel retention in C-2 case. Similar challenges do exist to draft, verify and validate C-2 severe accidents management guidelines (SAMGs) or the execution procedures with reference to control and mitigate the consequences of various probable severe accidents. This is one example from C-2 and nuclear power industry might have many other similar nature unsolved problems of the newly but fast emerging severe accident field.

Assuming nuclear power safety with reference to severe accidents is no more regional issue, then an active international collaboration or establishment of a joint research forum having clear mandate aimed at making and promoting the more safer and secure nuclear power can provide appropriate solutions to such unresolved problems. The various challenges involved in severe accidents analysis, codes preparation/validation and management guidelines drafting, verification and validation can also be addressed/resolved through such collaborations or joint platform. Such collaborations or joint research forum may also deliver few other useful and mutually beneficial byproducts.

5. CONCLUSION

In conclusion, it must be said that the new national regulations lay the foundation of a useful exercise to introduce and promote a new safety culture. This new safety culture may significantly improve the safety of existing and future nuclear power plants of the country. However, the application of this new safety culture does involve some serious challenges. Conceding that C-2 is not based on advanced design concepts, PAEC, through collaboration with the vendor/designer or international forums, is willing to put her best aimed at enhancing the plant safety. Nuclear power safety with reference to severe accidents should be treated as a global issue, therefore, it will be pertinent to give consideration to establish technical collaborations among the nuclear power industry itself and the entire nuclear power producing countries for the promotion of more safer and secure nuclear power, especially with reference to design and evaluate effective severe accidents encountering measures. The possible implementation of this idea is the inclusion of people from underdeveloped countries in various ongoing and future severe accidents based research and development programs of developed countries like severe accident codes preparation/validation, severe accident analysis, and management guidelines preparation. This may also deliver few useful and mutually beneficial byproducts.

REFERENCES

- [1] A PRACTICAL APPROACH TO APPLYING THE NEW IAEA SAFETY STANDARDS BASED NATIONAL LICENSING REQUIREMENTS TO CHASHMA NPP UNIT-2, By Ansar Parvez, Beijing, China, 2004.
- [2] ANGRA NUCLEAR POWER STATION, Preliminary Facility Description and Safety Analysis Report, Furnas Centrais Electricas S.A.
- [3] CALVERT CLIFFS NPP, Final Safety Analysis Report, Baltimore Gas and Electric Company
- [4] SNERDI Reference Documents
- [5] CHASHMA NUCLEAR POWER PROJECT UNIT-2, Technical Description, China National Nuclear Corporation
- [6] ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Level 2 PSA Methodology and Severe Accident Management, OCDE/GD (97) 198, Paris.
- [7] Walter J Moor, Basic Physical Chemistry, Prentice Hall of Pvt. Limited, 1989
- [8] Internet search engines like "google.com", <http://decay-heat.tripod.com> etc.

Cooperation with the Regulatory Body in the Review Process of Safety Conventions

K. Akutagawa^a

^a Safety Information Research Division,
Japan Nuclear Energy Safety Organization (JNES),
Tokyo, Japan

Abstract. In the review process of Safety Conventions, JNES supports the regulatory body making use of its expertise. JNES accumulates its experience and knowledge through the cooperative work with the regulatory body. This contributes to achieving the objectives of Safety Conventions.

1. Introduction

Japan is a contracting party of the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Safety Conventions). Contracting parties shall submit National Reports and attend Review Meetings in accordance with the provisions of the Safety Conventions. The National Report shall address the measures taken to implement the obligations of the Safety Convention as well as its safety policy and practices. At each Review Meeting, Contracting Parties discuss reports submitted by other Contracting Parties based on questions and answers exchanged in advance of the meeting. The Review Meetings of each Safety Convention are held in intervals of three years. These activities are called the review process.

The National Report of Japan is submitted by the government of Japan. The Nuclear and Industrial Safety Agency (NISA), a regulatory body for nuclear power for the utilization of energy, is a competent authority of the review process including preparation of the National Report and participation in the Review Meeting. The Japan Nuclear Energy Safety Organization (JNES) supports NISA as a technical support organization in the entire review process.

The second Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was held in May 2006 and the fourth Review Meeting of the Convention on Nuclear Safety is scheduled to be in April 2008.

2. Review process of the Safety Conventions

Contracting parties established some subsidiary rules in order to operate the review process

efficiently under each Convention. Those rules define administrative procedures, operation of the Review Meetings, the forms and structure of National Reports and so on.

2.1. Preparation of the National Reports

(a) The National Report shall address the measures taken to implement the obligations of the Safety Convention as well as the safety policy and practices. According to recent practices, the following subjects are addressed by most Contracting Parties to be included in the future National Report;

- solutions of challenges identified at the last Review Meeting,
- recent developments and accomplishments to improve safety.

(b) The National Report should be written to illustrate how the objectives of the Convention have been achieved compiling matters in paragraph (a). The National Report is originally written in Japanese and then translated into English.

2.2. Review of other Contracting Parties' National Reports

Contracting Parties should review other Contracting Parties' National Reports thoroughly. Based on this review, questions are posed in an individual National Report in writing prior to the Review Meeting.

2.3 Preparation of answers to questions

Contracting Parties should provide answers to the written questions in its National Report prior to the Review Meeting.

2.4. Participation in the Review Meeting

Contracting Parties have two obligations at the Review Meeting. One is presentation of a report based on its National Report and the ensuing questions for the review discussion with other Contracting Parties. The other is participation in the discussion of other Contracting Parties. Several Contracting Parties contribute to the Review Meeting providing officers as well.

3. Roles of JNES in the review process

JNES, as a technical support organization, cooperates with NISA in the review process making use of its expertise.

3.1. Scheme of cooperation with NISA

NISA and JNES share roles as described in Table I according to their original missions.

3.2. Cooperative system

NISA and JNES organize a cooperative system for the coordination among concerned domestic parties and experts. NISA coordinates within NISA and the government and with academic sectors. On the other hand, JNES coordinates within JNES and with licensees. This cooperative system has functioned well in order to reflect a wide variety of domestic activities to the National Report comprehensively.

3.3. Work schedule

Review Meetings are held with three years intervals. During intervals, concerned works proceed steadily as follows; (Mo. denotes Months)

- 18 Mo.: Starts developing basic outline of National Report,
- 16 Mo.: Starts drafting National Report,
- 10Mo.: Finalize National Report, Starts translation,
- 7Mo.: Submit National Report, Starts other National Reports review
- 3Mo.: Submit questions,
- 1Mo.: Submit answers,
- 0Mo.: Review Meeting

4. Achievements of cooperation

JNES accumulates its experience and knowledge through the cooperative work with NISA. This would be beneficial for activities of JNES as well as achieving objectives of Safety Conventions. Major achievements of cooperation are summarized as follows.

- **Accumulation of know-how to cope with the review process.** This could be succeeded in the future for the sake of sustainable evolution of Safety Conventions.
- **Cultivation of international human relationship.** In the Review Meeting, regulators and safety experts meet each other, exchange views and make human relationships. This could be helpful for the international activities of JNES.
- **Dissemination of international safety trends.** Review Meetings are unique fields for nuclear safety and regulation, and safety trends are shown there. JNES reports these trends domestically on all occasions.

5. Future challenges

JNES could contribute to the improvement of the review process with its accumulated experience and knowledge domestically and internationally.

5.1. Domestic challenges

Present cooperation process requires much effort and time. JNES would propose and implement measures to improve the domestic process efficiently for the sustainable

commitment to the Safety Conventions.

5.2. International challenge

There are needs to improve the review process among Contracting Parties. JNES could participate in the international discussions for improvement. Major subjects for improvement are as follows;

- the question and answer process,
- use of international safety standards,
- enhance efficiency of the review process,
- improve transparency between Contracting Parties.

Table I . Role sharing between NISA and JNES

<i>Ρεβιευ Προχεςσ</i>	<i>ΝΙΣΑ</i>	<i>θΝΕΣ</i>
<i>Νατιοναλ</i>	<i>– δεωελοπ βασιχ ουτλινε</i>	<i>– χολλεχτ ινφορματιον</i>
<i>Ρεπορτ</i>	<i>– χοορδινατε ωιτην</i>	<i>– δραφτ α ρεπορτ</i>
	<i>γοωερνμεντ</i>	<i>– χοορδινατε ωιτη λιχενσεεσ</i>
	<i>– χονσυлт ωιτη αδωισορψ</i>	
	<i>χομμιττεεσ *</i>	
	<i>– αππροωε τηε δραφτ ρεπορτ</i>	
<i>Ρεβιευ Οτηερ</i>	<i>– δραφτ θυεστιονσ</i>	<i>– αναλψζε οτηερ Νατιοναλ</i>
<i>Νατιοναλ</i>	<i>– αππροωε θυεστιονσ</i>	<i>Ρεπορτσ</i>
<i>Ρεπορτσ</i>		<i>– δραφτ θυεστιονσ</i>
		<i>– φολλοω-υπ προγρεσσ</i>
<i>Πρεπαρε</i>	<i>– δραφτ ανσωερσ</i>	<i>– δραφτ ανσωερσ</i>
<i>Ανσωερσ</i>	<i>– αππροωε ανσωερσ</i>	<i>– φολλοω-υπ προγρεσσ</i>
<i>Ρεβιευ Μεετινγ</i>	<i>– πρεσεντ οων ρεπορτ</i>	<i>– συππορτ δισχυσσιον</i>
	<i>– ρεσπονδ δισχυσσιον</i>	<i>– προωιδε οφφιχερσ</i>

* Advisory committees with persons of knowledge and experience are established by NISA to review the National Report drafts.

Sharing Good Practices of Radiation Exposure Reduction in Japan

Shigeyuki Wada^a

^a Safety Information Research Division,
Japan Nuclear Energy Safety Organization (JNES),
Tokyo, Japan

Abstract: The yearly average exposure dose per reactor in Japan is relatively higher than other major countries. JNES held ALARA symposiums in Asia calling persons from abroad participated to collect the information on good practices of radiation exposure reduction measures and to share such information for promoting ALARA activities of utilities.

1. Background and objectives

Operating commercial nuclear power plants in Japan count 32 BWRs and 23 PWRs, and 55 plants in total as March 31, 2006. Their total electric power generating capacity is 49,580 MWe. The number of radiation workers in FY 2005 was about 66,300, and their total dose was 66.91 person-Sv, which meant the average dose per radiation worker was 1.0 mSv, and the yearly average exposure dose per reactor was 1.2 person-Sv. The exposure dose per reactor in 1980, however, was about 600 man rem (6 person-Sv), which was relatively higher than other major countries. As the results of taking comprehensive measures such as installation of condensate filters, adoption of low-cobalt materials for reactor structural materials, and reinforcement of radiation shielding, the exposure dose level was reduced to the level of about one person-Sv per reactor in 1990s, and such level was retained after that. However, as the results of continuous decreasing trend of radiation dose in the major countries, the yearly average exposure dose in Japan is now again at the relatively higher level (see FIG.1).

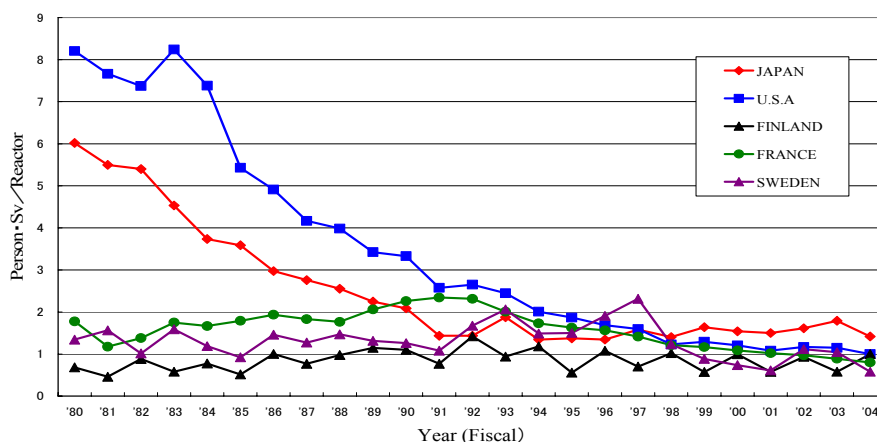


FIG.1 Trends of Annual Exposure per Reactor by Country

For BWR plants in Japan, the measures to reduce crud such as oxygen injection into feedwater, measures to reduce Co-60 generation such as adoption of materials containing low cobalt for fuel spacer spring and others, zinc injection to the primary system, reinforcement of decontamination and radiation shielding, and adoption of automatized equipments such as automatic exchanger of control rod drive mechanism, have been performed. For PWR plants, measures for crud reduction, such as optimum pH control of primary coolant during operation, oxidation operation and increase of clean-up flow during shutdown, measures to reduce Co-60 generation such as adoption of materials containing low cobalt for core internal structures, zinc injection to the primary system, reinforcement of decontamination and radiation shielding, and adoption of automatized equipments such as work robot in the water chamber of steam generator, have been performed. As the results of these measures, the radiation dose rate on the piping surface of primary system becomes the same level as that of the major countries. Although the work radiation circumstances are the same as that of the major countries, it seems that there exists a difference of workloads.

It is needed for utilities to make further efforts for exposure dose reduction and to increase awareness of exposure dose reduction. JNES has been collecting information on good practices of ALARA activities of utilities and held the ALARA Symposiums of ISOE in Asia in 2005 and 2006 to share such information. From Japanese utilities and JNES, 26 persons participated and 20 persons from abroad participated in the first symposium, and 38 persons from Japanese utilities, manufactures and JNES and 3 persons from abroad participated in the second symposium.

2. Good practices of ALARA

Table.1 and Table.2 show the titles of papers presented at the Symposiums.

Table.1 Titles presented at 2005 ALARA Workshop

1.	North American Occupational Dose Trends
2.	The Example of the Workers Internal Contamination Practices
3.	Current Status in Korean NPPs
4.	Measures to Reduce Radiation Exposure during the RV Core Internals Replacement at Ikata Nuclear Power Station Unit-1
5.	Activities for Dose Reduction (Hamaoka NPPs)
6.	Dose Rate Reduction Experience of Piping Replacement at Fukushima Daiichi Unit 4 and 5
7.	Dose Reduction Measures at Shika Nuclear Power Station Unit-1
8.	Unit 2, Genkai Nuclear Power Plant –Replacement Works for the Steam Generator and the Reactor Pressure Vessel Upper Head
9.	Demonstration of Zinc Injection Technique in Fugen Nuclear Power Station

Table.2 Titles presented at 2006 ALARA Symposium

1. Summary Report of the EPRI Standard Radiation Monitoring Program
2. Occupational Exposure at Japanese Nuclear Power Plants in 2005
3. Our Decontamination Technologies for NPSs
4. Approach of Hitachi for Dose Rate Reduction
5. Introduction of the Decontamination Method Which Used the Blasting
6. ALARA Programs and Occupational Dose Trends in Wolsong NPPs
7. Progress of the Zinc Injection in Tsuruga NPP Unit 2
8. Measures for Containing an Increase in Pipes' dose-equivalent Rate in the Hydrogen-injected Environment at the Shimane Nuclear Power Station Unit 1
9. ONAGAWA N.P.S Dose Reduction
10. ALARA Activities at Ohi NPP
11. Improvement of TEPCO's ALARA Process

The followings are the examples which will give useful information for radiation exposure reduction:

- (1) Measures to Reduce Radiation Exposure during the RV Core Internals Replacement at Ikata Nuclear Power Station Unit-1 (November, 2005, Shikoku Electric Power Co.,Inc.)

At Unit 1 of Ikata Nuclear Power Station (PWR, 566 MWe), additional control rod clusters were installed to introduce high burn up fuel. For this modification, the works to replace the core internal structures were conducted, as a part of the works of installation of control rod cluster guide tube. When the core internals (*FIG. 2*) were replaced, the equipment for replacing core internals (*FIG. 3*) and the temporary radiation shielding were installed, and training using a mock-up was performed to reduce radiation exposure. As the results of these efforts, exposure dose was kept to 0.14 person-Sv, less than one tenth of the expected dose (1.8 person-Sv).

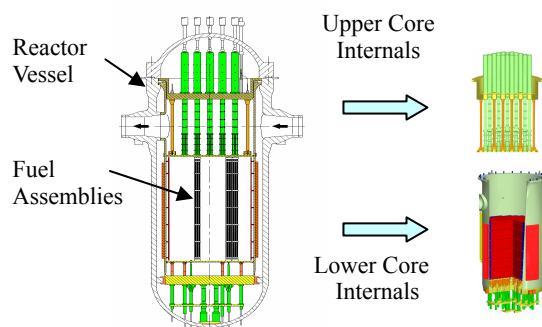


FIG.2 Scope of Core Internals(CI) Replacement

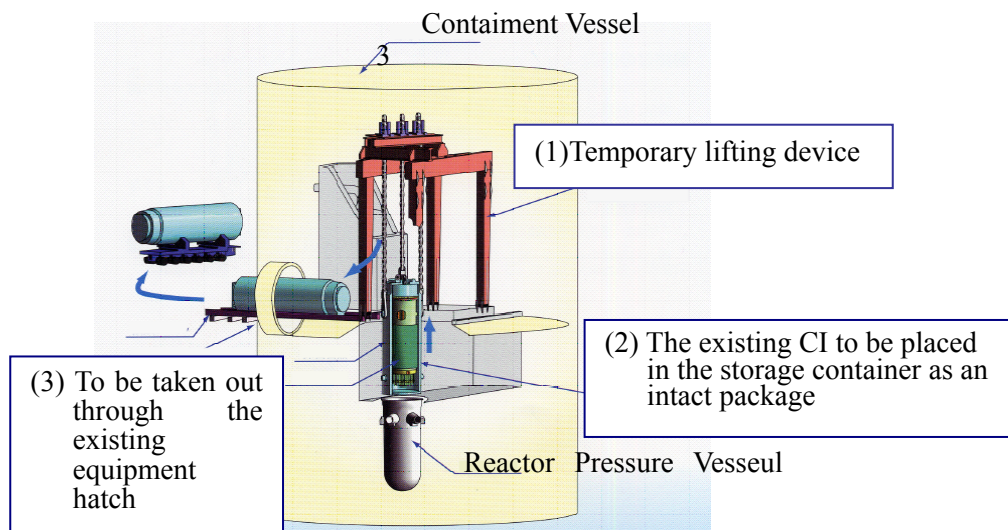


FIG.3 Conceptual Drawing for CI Replacement

(2) ALARA Activities at Ohi NPP (October, 2006, The Kansai Electric Power Co., Inc.)

Ohi Power Station with 4 units (PWR, 1,175 MWe x 2, 1,180 MWe x 2) set a goal of yearly exposure dose (three year rolling average) during the periodic inspection outage (except outage for modification) to reduce from the current about 3.4 person-Sv per four units to 1.4 person-Sv. As the results of review on exposure dose reduction measures for overhaul of reactor cooling pump (RCP), which accounted for about 40% of exposure dose during the periodic inspection outage, it was concluded that the introduction of the measures such as ultrasonic cleaning, reinforcement of radiation shielding in the repair room, introduction of dedicated shielded vessel for curtailing works of maintenance, measurement and inspection for the impeller, and the improvement of the internal hoist for reducing workloads, were all effective. It is expected that the current exposure dose (211 person-mSv) will be decreased to 129 person-mSv by 82 person-mSv reduction. The effectiveness of these exposure dose reduction measures will be identified during the periodic inspection outage in 2008.

3. Conclusion

JNES held the ALARA Symposiums of ISOE in Asia in 2005 and 2006, to collect the information on good practices of radiation exposure reduction measures and to share such information for promoting ALARA activities of utilities. At the Symposium in 2006, the participants

from abroad, as well as participants from Japanese utilities and manufactures, made presentations actively and the attendance could get knowledge on exposure dose reduction, resulting in raising their consciousness on the issue. It is very important for persons related to exposure dose reduction to meet together to exchange information, and the next meeting is being prepared to be held in the Republic of Korea next year.

Perspective of evolving needs for Advanced Analysis and Evaluation Methods

Fumio Kasahara, Shigeo Ebata, Yaich Otsuka, Maso Ogino

Japan Nuclear Energy Safety Organization (JNES)
Kamiya-cho MT Bldg. 4-3-20 Toranomon, Minato-ku,
Tokyo, 105-0001, Japan

Abstract. This paper describes the current activity in Japan Nuclear Energy Safety Organization (JNES) for the perspective of evolving needs for advanced analysis and evaluation methods. The status of the development and application of the advanced methods are presented such as the Best Estimate codes and its application to LWRs, the CFD codes and its application to Fuel Cycle Facilities and Severe Accident Analysis, etc.

1. Introduction

Regulatory needs for the advanced analytical methods for the review and assessment of the licensing applications are increasing. For example, power uprates, life extension or increased fuel burnup as well as cumulative effects of simultaneous or subsequent design changes in a plant, can challenge original safety margins while fulfilling all the regulatory requirements. It has been recognized that currently used methods for safety analysis may not be sufficient to guarantee that enough safety margin exists and more advanced analysis methods are needed to quantify the safety margin. The needs of the advanced evaluation method are also increasing in for the safety review of newly established nuclear fuel facilities, the probabilistic safety assessments (PSA) especially for the severe accident analyses, etc. For these purposes we upgrade and qualify safety analysis codes (including analysis methods) based on the up-to-date needs and technical knowledge.

2. Best Estimate codes and its application to LWRs

Current licensing analyses in Japan, for abnormal operational transients and accidents, are based on the deterministic approach, using rather simple analysis model such as point reactor kinetics with ample analysis margin. However, recent progress of computer capability and analysis method enable the more detailed safety analysis based on the statistical approach such as BEPU (Best Estimate code Plus Uncertainty) method, which provides us with quantitative information of the analysis uncertainties in rationalizing the appropriateness of safety margin (Fig.1). Japanese utilities are now planning to apply these methods to the future licensing application of the plant modification such as power up-rate, high burn-up, cycle extension, etc. On the basis of these circumstances, we also have been developing these methodologies in order to evaluate that the safety margin is surely maintained in these plant modifications and to provide the regulatory body (METI) with the appropriate licensing decision-making information. From such purposes, we are equipped with the best estimate (BE) codes such as 3-dimensional neutron kinetics thermal hydraulic analysis code SKETCH-INS/TRAC, TRACE, etc. as well as developing the statistical analysis methods (Fig.2, Fig3).

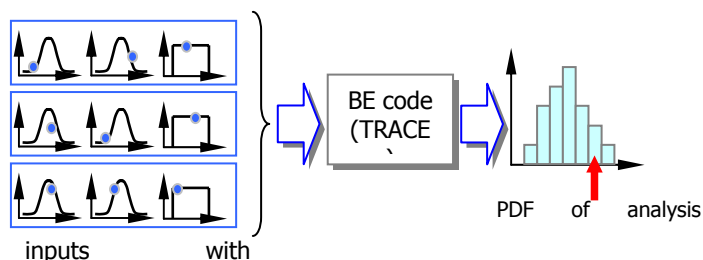


Fig.1 Concept of BEPU analysis

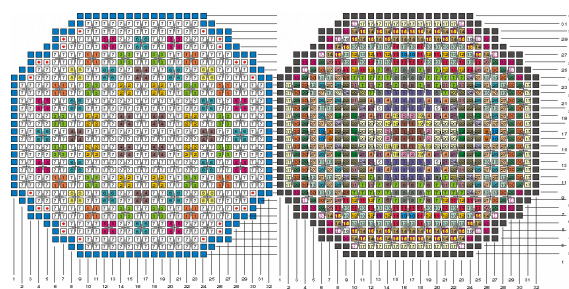


Fig.2 BWR 3D core model of SKETCH-INS (nuclear and thermal grouping)

Another application of the best estimate code is of the simulation of actual plant behavior relating to event trace of plant trouble and its review of appropriateness of the countermeasures. For this purpose, we maintain the actual plant analysis data which contain more detailed model than the licensing analysis, including control systems and various mitigation systems.

Furthermore, best estimate code is now planning to be applied to the plant aging evaluation such as PTS (pressurized thermal shock) which is important to the aged plants in future from the regulatory viewpoint. The best estimate code analysis results are utilized in defining the thermal hydraulic condition in these aging evaluations. Figure 4 shows the example of TRACE code modeling for PTS.

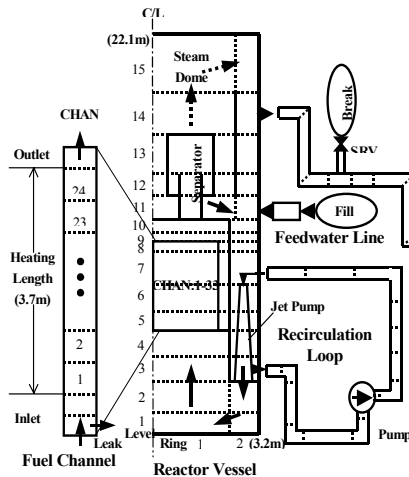


Fig.3 BWR plant model of SKETCH-INS/TRAC-BF1

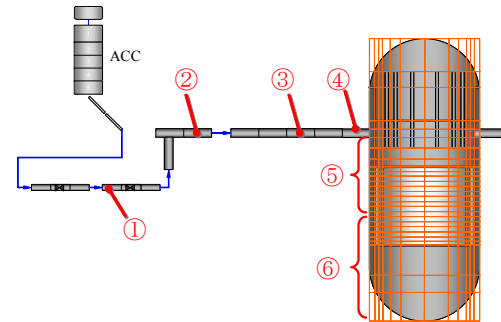


Fig.4 TRACE analysis for PTS evaluation

3. CFD codes and its application to Fuel Cycle Facilities

We support the safety review of the regulatory body by means of audit analysis (we call it cross-check analysis). For this purpose we upgrade and qualify safety analysis codes (including analysis methods) based on the up-to-date needs and technical knowledge. We applied some CFD (Computational Fluid Dynamics) codes for the analyses of nuclear fuel facilities such as MOX fuel fabrication facilities, interim spent fuel storage facilities or the vitrified package storage facility. Figure 5 shows the image of interim spent fuel storage facility.

For example, PHOENICS and/or FLUENT codes have been applied to the atmospheric temperature analysis in conjunction with heat flow both in the spent fuel storage cask and in the storage facility. Figure 6 shows the analysis results of cooling air temperature and velocity in the interim spent fuel storage facility. The analysis codes are validated by conducting benchmark analyses etc. Therefore, analytical accuracies are upgraded and analytical functions are expanded for the codes.



Fig. 5 Image of interim spent fuel storage facility (natural air ventilation system)

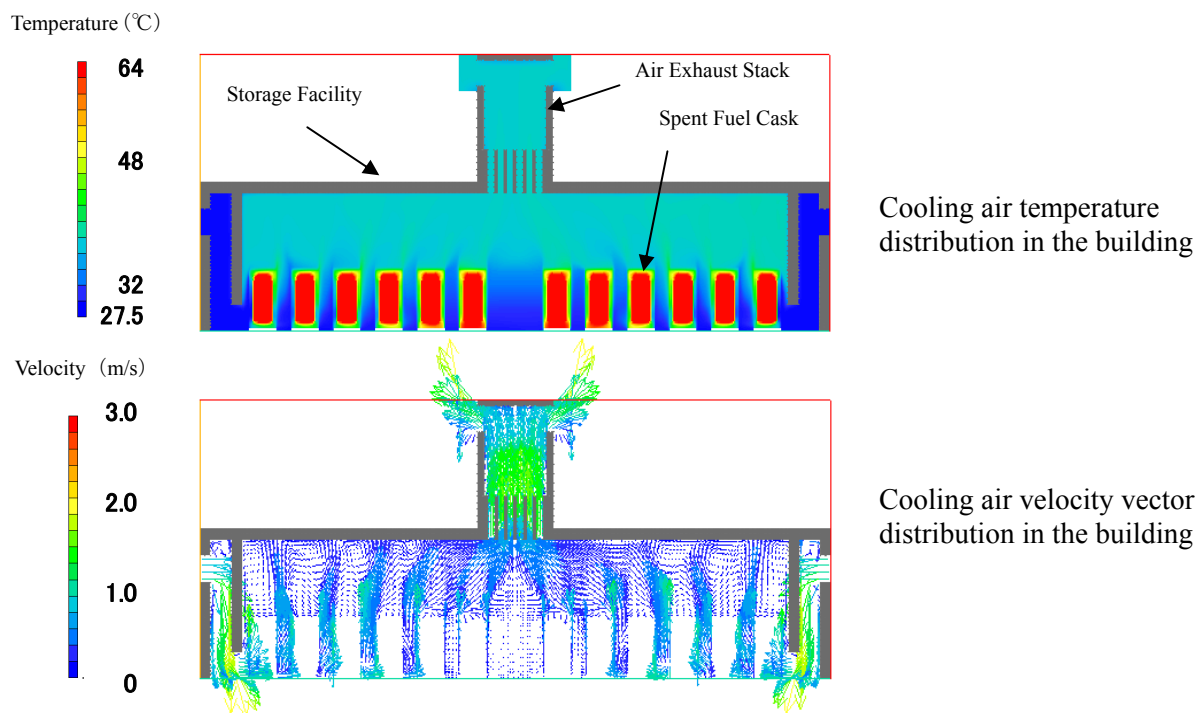


Fig.6 Analysis results of cooling air temperature and velocity by PHOENICS code (For example only)

4. CFD applications to Severe Accident Analysis

With the progress of probabilistic safety assessments (PSA) applications, the severe accident progression analysis codes, used in the PSA, are needed for higher qualification and reliability. Lumped-parameter severe accident analysis code has been extensively applied to the level 2 PSAs, the examination of the effectiveness of severe accident managements (AMs) and other risk analyses of the LWRs in Japan. However, many severe accident phenomena have not been yet sufficiently modeled, and local complex geometries and transport behaviors have not been taking into account in the lumped parameter severe accident analysis codes.

In those circumstances, the JNES is paying efforts in the improvement of the severe accident progression analysis codes with following approaches: (1) Code validation with existing experimental data, (2) International cooperative experimental research for quantifying and understanding key phenomena, which are not yet sufficiently investigated and modeled, (3) Applications of computational fluid dynamics (CFD) to tracking and delineation of the local and detail transport phenomena inside a complex geometry, and (4) Implementation of the CFD mechanistic approach to the lumped parameter code in the conventional analysis methodology (empirical models).

Figure 7 shows an example of application of the CFD technique to the prediction of the local flow pattern in a multi-compartment containment vessel (CV). Steam gas, released at a part of the lower compartment, mixed almost completely with the air in whole CV by natural convection and the atmospheric temperature was almost homogeneous, which showed an effective cooling of recirculation cooler.

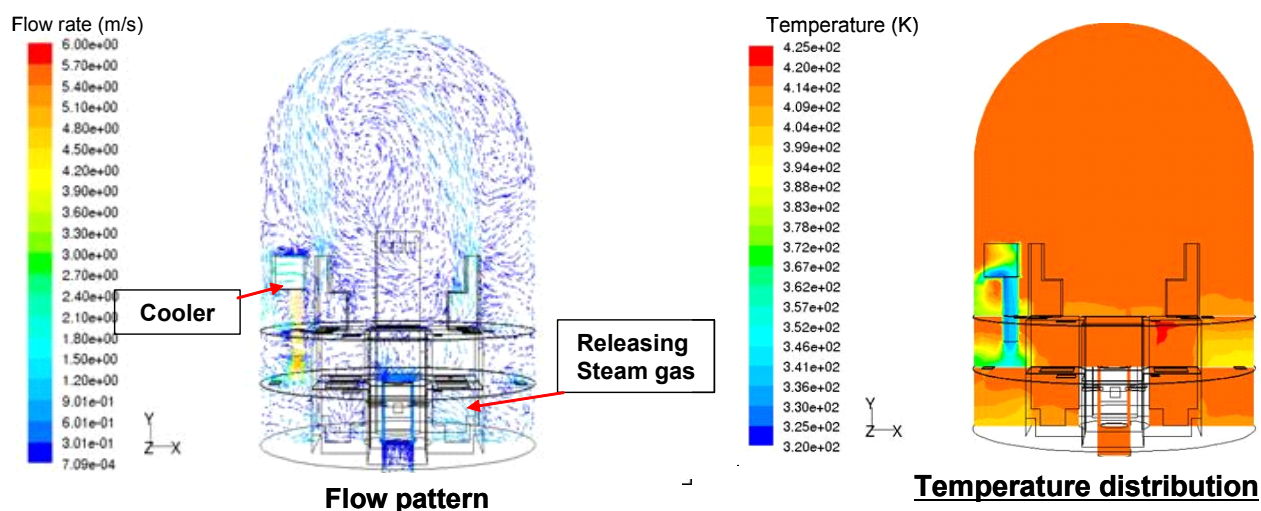


Fig.7 CFD code applications to the examination of the effectiveness of containment cooling AM

5. Summary

The upgrade and qualification of safety analysis codes such as BE codes, CFD codes and their application to LWRs, Fuel Cycle Facilities and severe accident analyses have been progressing in JNES. In this paper the status of the development and application of the advanced method to the facilities and accident analyses are presented. We are continuing the efforts to provide the regulatory body the rational evaluation tools in the decision making process.

Development of Technical Information Basis of Aging Management for Nuclear Power Plants

M. Kanno^a

^a Safety Standard Division
Japan Nuclear Energy Safety Organization, Tokyo, Japan

Abstract.

In order to implement effective safety regulations on aging management for reactor facilities etc., the information on important technology issues, the latest technical knowledge including evaluation technology, test and research outcomes, related codes and standards, regulation information, operation experiences such as accidents and trouble, etc. with respect to aging-induced deterioration in and outside Japan and in other industries, were collected, organized and evaluated.

1. Background and objectives

As the Higashidoori Nuclear Power Station Unit 1 of Tohoku Electric Power Co., Inc. and the Shika Nuclear Power Station Unit 2 of Hokuriku Electric Power Co., Inc. started their commercial operation on December 8, 2005 and March 15, 2006, respectively, the number of commercial nuclear power plants in Japan is 55 units as of March 2005 and ranks the third after the U.S.A. (103 units) and France (59 units). In addition, the number of plants exceeding 30 years after the start of their commercial operation will reach 20 units in 2010, and one of those plants will see even its 40th anniversary after the start of its commercial operation in the same year. Under these circumstances the aging management of nuclear power plants has been one of the key issues from the viewpoint of maintaining safety and reliability of nuclear power plants. The Agency of Natural Resources and Energy, Ministry of International Trade and Industry (the current Nuclear and Industrial Safety Agency, Ministry of Economy, Trade and Industry (hereinafter referred to as "NISA")), conducted the fitness-for-service assessment for major equipment important to safety and the study on the adequacy of the current maintenance practice, assuming 60-year service for three nuclear power plants built at an early stage, and developed the basic policy on aging issues and released it publicly in April 1996. Based on these assessment results, electric utilities conducted technical evaluations regarding aging and the adequacy evaluations of their current maintenance programs on equipment especially important to safety and continuous operation, and developed and submitted new long-term maintenance programs addressing aging management to the Agency. In February 1999, the Agency reviewed those technical aging evaluations and development of long-term maintenance programs, and determined that those were reasonable and adequate, and concluded that the following three items were key issues to be addressed as specific activities on the future aging management.

- (1) Establishment of comprehensive facility management policies on further enhancement of the periodic safety review, the periodic inspection etc.

- (2) Development of the standards and codes addressing aging deterioration, such as an introduction of an equipment maintenance standard
- (3) Promotion of the technological developments in the areas of "inspection and monitoring technology", "aging evaluation technology" and "preventive maintenance and repair technology"

As a part of the specific activities on aging mentioned above, the aging management of the the Mihama Power Station Unit 2 and the Fukushima Daiichi Nuclear Power Station Unit 2 was reported in June 2001, and the technical evaluation (PLM) was carried out during their periodic safety review (PSR) for the first time. Stipulation of the technical evaluation (PLM) on aging reactor facilities into Article 15-2 and Article 16 of the Rules for Installation, Operation etc. of Commercial Power Reactors in September 2003 asked for further response to this issue, and the system modification in October 2003 made these utilities' measures statutory requirements and the Government to check their implementation status by the fitness-for-safety inspection etc. Furthermore, the NISA decided that it was important to obtain an understanding of the national public and residents in the vicinity of nuclear power stations by conducting meticulous activities, such as "effective technological development", "buildup of engineering data and systematic development of criteria" and "public information release on aging management activities", and also to address technology exchange and cooperation, etc. with Europe and the United States. Then, the secondary system pipe rupture accident that occurred on August 9, 2004 at the Mihama Power Station Unit 3 of the Kansai Electric Power Co., Inc. triggered heightened interest in the aging issues of nuclear power plants from the local governments to the public. Under these circumstances, NISA thought that it was necessary to study what should be done as specific activities towards the newly enhanced aging management by electric utilities, and established the "Committee on Study of Aging Management" in the Advisory Committee on Nuclear and Industrial Safety in December 2004.

Under these circumstances, development of technical information basis of aging management has been promoted since 2000 as an indispensable matter to the resolution of issues regarding aging, improving and enhancing technical basis with respect to aging and utilizing achievements of technological development in order to ensure safety and reliability of nuclear power plants. With inauguration of the Incorporated Administrative Agency, Japan Nuclear Energy Safety Organization (hereinafter referred to as "JNES") in October 2003 after that, this program was transferred to JNES and restarted.

It is known that physical properties and characteristics will change in general when equipment and structures are exposed to dynamic environment, thermal environment, radiation environment etc. As deterioration events due to aging at nuclear power plants, there could be fatigue, neutron-irradiation induced embrittlement, stress corrosion cracking, heat aging, corrosion etc. The nuclear power plants in Japan have shown the high capacity factor exceeding 80% and the low unscheduled outage rate, and it can be said that deterioration events due to aging have been well managed by enhanced periodical inspection and check, and routine maintenance management. However, assuming a long service time of 60 years, it cannot be denied that deterioration events could become real and progress.

Although it is generally thought that the number of trouble increases first from nuclear power plants with long operation years, the trend that the number of trouble increases with the increase in operation years has not been actually recognized, and therefore, aging does not likely to pose an immediate problem. However, since it is important to take all possible measures with respect to safety of nuclear power plants, it is considered appropriate that plants with service life exceeding 30 years since their start of operation should initiate aging management. In addition, it is essential to obtain the understanding of the general public as well as the residents in site areas as a part of promotion of aging management, but the general public are not generally familiar with these issues, and therefore, there is a concern that aging is likely to be considered only to compromise safety of nuclear power plants. Taking fully into account this kind of mindset, concerns etc., it is important to make efforts to promote required technical development for collecting and accumulating the technical information, and to obtain the understanding and cooperation of the general public through providing those information obtained to the public. Under such background, JNES has started the development of the technical information basis for aging management of nuclear power plants with the purpose of contributing to implementation of the effective safety regulations to aging of nuclear power plants and fostering the understanding of the general public in Japan.

2. Development of technical information basis

In order to implement effective safety regulations on aging management for reactor facilities etc., the information on important technology issues, the latest technical knowledge including evaluation technology, test and research outcomes, related codes and standards, regulation information, operation experiences such as accidents and trouble, etc. with respect to aging-induced deterioration in and outside Japan and in other industries, were collected, organized and evaluated.

(1) Development of database for aging technical evaluation

In December 2005, the Nuclear and Industrial Safety Agency released the "Guideline on Implementation of Aging Management at Reactor Facilities for Commercial Power Generation" and the "Standard Examination Procedure on Aging Management (bylaw)." Along with support to prepare these guidelines, JNES prepared the "Examination Manual for Technical Evaluation of Aging" for each aging event and developed the technical information basis for technical evaluation of aging, etc. reflecting the latest technical knowledge. As an example, the collection status on accident and failure information from domestic and overseas plants regarding aging is outlined below;

(a) Domestic plants

Survey and analysis of accident and failure information on domestic light water reactors in 2005 fiscal year (reporting required by the Law and Notice) found 15 troubles. Using some of those cases possibly related to aging as the latest operation experiences and confirmation items, it was checked without delay whether the same measures taken against aging in those cases were considered for each equipment during examination (hearing or on-the-spot inspection of

NISA (field investigation of JNES)) of the aging technical evaluation reports of the Unit 3 of the Fukushima Daiichi Nuclear Power Station and the Unit 1 of Hamaoka Nuclear Power Station. Information sources for domestic accidents and troubles include the followings;

- JNES Annual Report on Operation Status of Nuclear Facilities in Japan (2005 editions)
- JNES homepage
(Domestic trouble information, <http://www2.jnes.go.jp/atom-db/jp/index.html>)
- NISA homepage (accident and trouble information)
(http://www.meti.go.jp/interface/nisa/regularly/3_announce/info.cgi?category=3)
- Public Information Library on Nuclear Facilities, Limited Liability Intermediate Agency, Japan Nuclear Technology Institute
(NUCIA), (<http://www.nucia.jp/>)

(b) Overseas plants

The information described in the Information Notice¹, Bulletin² and Generic Letter³ of the U.S. NRC (Nuclear Regulatory Commission) collected by 2005 fiscal year were reviewed and analyzed as overseas accident and failure information, and abridged translations were added to the information considered important.

In addition, these trouble-related information and regulation information were released on the following JNES homepage;

- "Analysis result of the NRC information "
(<http://www.jnes.go.jp/database/koukeinenkasyu.html>)

(2) Support for the Committee on Study of Aging Management etc.

(a) The Committee on Study of Aging Management, Technical Review WG on Aging, and Technical Evaluation WG on Aging of NISA

In 2005 fiscal year, 13 meetings in total to enhance aging management including 4 meetings of the Committee on Study of Aging Management, 4 meetings of the Technical Review WG on Aging and 5 meetings of the Technical Evaluation WG on Aging were held. JNES supported NISA in preparing various related materials concerning aging, etc.

(b) The Technical Information Coordinating Committee, Information Basis WG, Safety Research

¹ This is the notice that the Office of Nuclear Reactor Regulation (NRR) of the U.S.A. issues, and is usually used in order to caution licensees about the latest safety and failure information. The information recipients are expected to review its applicability to their facilities to avoid an occurrence of the similar problem and take appropriate actions.

² This is the letter that the Office of Nuclear Reactor Regulation (NRR) of the U.S.A. issues to licensees, and describes the standpoint and technical instruction of the NRC staff on individual problem. When the NRR requests an opinion and information submittal, its request is legally binding.

³ This is the official bulletin published by the Bureau of Investigation Enforcement (I&E) to the nuclear industry and the public and is not legally binding, but the injunctive letter which NRR, Director of I&E, or NRC Commission Member issues to the specific licensee with respect to a unique or specific problem has legally binding force.

WG, and International Cooperation WG in JNES

The Committee and WGs have been set up within JNES to realize “development of technical information basis (collection / organization and utilization of technical information, selection and implementation of safety researches, international evolution of the technical information basis, and roles of industry, academia and government and their organic coordination)”, which is one of new measures described in the report “Enhancement of Aging Management at Reactor Facilities for Commercial Power Generation” of the Committee on Study of Aging Management. Minutes and handout materials of the Committee on Study of Aging Management and the Technical Evaluation WG on Aging and others of the Government can be found at <http://www.nisa.meti.go.jp/00000004/04a00000.htm>, and of the Technical Information Coordinating Committee of JNES at http://www.jnes.go.jp/katsudou/jyouhou_index.html.

(3) Development of database for preparation of examination manuals etc. on aging technical evaluation

Examination manuals and the database for aging technical evaluation were developed on the following items in 2005 fiscal year;

- (i) Preparation of examination manuals on aging technical evaluation
 - Neutron-irradiation induced brittlement of reactor pressure vessel
 - Stress corrosion cracking
 - Fatigue
 - Pipe wall thinning
 - Insulation degradation of electric instrumentation equipment
 - Reduction in strength and degradation in shielding capability of concrete
 - Seismic safety evaluation
 - Concept and viewpoint of efforts to prevent organization culture deterioration

The examination manuals were released on the JNES homepage with the following URL.

<http://www.jnes.go.jp/database/koukeinenkasyu.html>

- (ii) Survey of aging management in other industries
- (iii) Survey of organization culture and safety culture evaluation method
- (iv) Survey of durability and alkali-aggregate reaction of concrete structures etc.,
- (v) Enhancement of engineering database related to aging (BWR and PWR)
- (vi) Survey of trend in operating license renewal in the industrial world
 - Collection of LERs, and technical comparison and evaluation between operating license renewal in the U.S.A and that in Japan

(4) Aging technical evaluation

In accordance with the newly established guidelines, standard examination procedures, and examination manuals, the aging technical evaluations of the Fukushima Daiichi Nuclear Power

Station Unit 3, the Hamaoka Nuclear Power Station Unit 1, and the Mihama Power Station Unit 3 were completed. The reports on the examination results of aging technical evaluation etc. of those three plants are available on the JNES homepage mentioned below. In order to ensure that all relevant equipment are covered, the verification of technical adequacy is also carried out using checklists.

<http://www.jnes.go.jp/database/koukeinenkasyu.html#001>

(5) Establishment of a follow-up system for long-term maintenance program

The "follow-up system for long-term maintenance program" to ensure that a long-term maintenance program is carried out in accordance with a maintenance management program and to control the status putting the implementation status into the database is completed. This is a support tool to confirm whether the long-term maintenance program within the report of aging technical evaluation etc. describing various additional maintenance measures is implemented without fail.

3. Utilization of the achievements

The achievements described so far were reflected in the establishment of the "Guideline on Aging at Reactor Facilities for Commercial Power Generation" and "Standard Examination Procedure on Aging Management at Reactor Facilities for Commercial Power Generation (bylaw)" published by the Government after review by the "Committee on Study of Aging Management, and eight examination manuals for aging technical evaluation published by JNES: "Neutron-Irradiation Induced Brittleness of Reactor Pressure Vessel", "Stress Corrosion Cracking", "Fatigue", "Pipe Wall Thinning", "Insulation Degradation of Electric Instrumentation Equipment", "Reduction in Strength and Degradation in Shielding Capability of Concrete", "Seismic Safety Evaluation", and "Concept and Viewpoint on Efforts to Prevent Organization Culture Deterioration." Moreover, this information was utilized for the deliberations in the Committee on Study of Aging Management, Technical Review WG on Aging, and Technical Evaluation WG on Aging hosted by the Nuclear and Industrial Safety Agency, and the Technical Information Coordinating Committee etc. hosted by JNES.

- (1) The technical information concerning aging from the IAEA, United Kingdom, France, aircraft industry etc. was collected, and it was utilized for the establishment of the Guideline on Aging Management etc.
- (2) Investigation and study concerning concrete, information enhancement of the JNES homepage related to aging, and information collection of operating license renewal in the U.S.A. etc. were performed attaining the achievements as planned, and they were also utilized for the establishment of the Guideline on Aging Management etc.
- (3) In accordance with the Guideline on Aging Management etc. reflecting the achievements of JNES activities in this fiscal year, JNES conducted the aging technical evaluation of three plants which were getting on 30th year after their start of operation, verified the technical adequacy of the contents described in their reports, reported the results to the Nuclear and Industrial Safety Agency, and

released those results on the JNES homepage after the deliberations of them at the Technical Evaluation WG on Aging.

- (4) Trial of the follow-up system for long-term maintenance programs based on aging technical evaluation results was completed. From now on, JNES will support the Nuclear and Industrial Safety Agency by inputting the long-term maintenance programs reported to the Government one by one.

“Recent Engineering Support Activities for Establishment of Regulatory Guidelines and Standards Related to the Safety of Radioactive Waste Disposal and Decommissioning”

H. Kawakami

Safety Standard Division

Japan Nuclear Energy Safety Organization (JNES), Tokyo, Japan

Abstract. This paper describes the recent engineering support activities that the Radioactive Wastes Assessment Office in the Japan Nuclear Energy Safety Organization (JNES) carried out for the Nuclear and Industrial Safety Agency (NISA) with regard to the establishment of regulatory guidelines and standards related to the safety of radioactive waste disposal and decommissioning. It also describes not only the support activities that JNES performed to settle the new systems of rational and scientific safety regulations related to the safety of radioactive waste disposal and decommissioning and clearance legislation system in the Japanese society, but also the recent efforts that JNES made in connection with the establishment of the legislative system and regulatory guidelines and standards on the safety of radioactive waste disposal in the disposal facilities planned to be constructed in the future such as intermediate depth repository and geological repository. It is expected that all the organizations supporting the establishment of safety regulations will work together to conduct their safety research efficiently and effectively under the direction of NISA, and that JNES will play a more and more important role as the coordinator of these technically supporting organizations.

1. Roles of JNES in Radioactive Waste Disposal and Decommissioning

In response to the medium-term objectives provided by NISA, JNES drew up and submitted its medium-term and annual programs to NISA, and has carried out its tasks according to these programs. In the fields of radioactive waste disposal and decommissioning, NISA provided the following medium-term objectives to be achieved by the end of this year:

(1) Investigations on the safety of decommissioning

To ensure the safety of decommissioning, investigations will be carried out into the impact of dismantling work on the environment, and safety assessment techniques for decommissioning will be established from discussions on problems caused by decommissioning and the measures taken to combat these problems.

(2) Investigations on the techniques for confirming clearance levels

To improve the reliability and efficiency of the clearance system, investigations will be carried out on the techniques for confirming the accurate measurement of clearance levels, and studies will be conducted on the measures to be taken in the case that it is questionable whether the measured value of any substance is below the clearance level.

(3) Investigations on radioactive waste disposal

To establish the standards and rules, as well as the safety assessment techniques for the safety of low- and high-level radioactive waste disposal, investigations and reviews will be carried out on domestic and foreign standards, rules, and safety assessment techniques for radioactive waste disposal.

The results of safety research conducted by JNES will be basically reviewed by the council organized within JNES and which will include external experts. The results of the reviews will be reported to NISA and published as the Report of Activities. Some results of safety research will be directly reported by JNES to the technical committees or subcommittees on radioactive waste disposal and decommissioning within the Nuclear Safety Commission (NSC), and may be used as references if guidelines on safety reviews are prepared by NSC.

The topics in each field of the recent engineering support activities that JNES carried out in regard to the establishment of regulatory guidelines and standards related to the safety of radioactive waste disposal and decommissioning are described below.

2. Decommissioning

The amended Nuclear Reactor Regulation Law, into which the approval system for decommissioning plan and the clearance system were incorporated, was established and enforced together with the related Government and ministry ordinances in December 2005. Under the new law and ordinances, Japan Atomic Power Company's Tokai Power Station made an application for the approval of its first decommissioning plan, and launched the new 2nd phase of its dismantling work. The Japan Atomic Energy Agency is also preparing to apply for approval for decommissioning plans of the Advanced Thermal Reactor Fugen and its uranium enrichment pilot plant at Ningyo-tohge. Various decommissioning projects are expected to be implemented in the future.

From the viewpoint of rational safety regulations, it is important to understand the transport behavior of radioactive substances released by dismantling of any contaminated equipment, to verify exposure assessment models, and to make a realistic safety assessment while confirming safety margin. Therefore, JNES is actively working together with other organizations supporting the establishment of safety regulations to prepare a handbook on such safety assessment models for decommissioning and data on the behavior of dust produced by dismantling. If any facility is dismantled, workers are most likely to be exposed to dust produced by cutting materials containing radioactively contaminated substances or radioactivated metals. In particular, when thermal cutting equipment is used, elements with a higher vapor pressure at a low melting point or low temperature may be more rapidly evaporated than others, and released in the form of dust into the environment. JNES is now conducting hot testing on the dust produced by cutting and the radionuclides dispersed from heat-affected zones [1]. Based on these results as well as the results of the investigation that will be carried out on dismantling the real equipment, JNES plans to further improve the Handbook of Environmental Impact Assessment.

3. Clearance

The clearance system was legislated in May 2005 and enforced together with the related Government and ministry ordinances in December 2005. Under the new law and ordinances, Japan Atomic Power Company's Tokai Power Station made an application for the approval of its clearance measurement and evaluation methods in June, 2006 and obtained approval in September [2]. Thus, clearance measurements

will begin to be made. Then, applications will be made for clearance confirmation, and the first clearance release will be implemented in Japan after the Government (or partially JNES) has confirmed that measured values were below the clearance levels.

Under the clearance system, JNES plays the dual role of giving technical assistance to NISA who evaluate the compliance of the clearance measurement and evaluation methods by operators, and confirming the results of clearance measurements made by operators. In particular, in giving technical assistance to NISA, JNES not only checks the performance of clearance measuring apparatus used by operators to ensure that clearance levels will be appropriately measured and assessed, but also investigates the techniques for sampling, measuring and evaluating the nuclides and concentrations of radioactive substances contained in contaminated or radioactivated materials subjected to clearance confirmation. JNES established the techniques for evaluating the performances of clearance measuring systems using simulated sources, applied the techniques to the real clearance equipment in Tokai Power Station, and confirmed that the clearance equipment had the specified performance. In the future, JNES plans to investigate the clearance system for nuclear fuel cycle facilities for which there is currently no legislation.

4. Radioactive Waste Disposal

4.1. Confirmation of low-level radioactive waste disposal

With regard to homogeneous or uniform solidified *ωαστεσ (ΗΥΣΩ) ανδ χονταινερ-φίλλεδ ανδ σολιδιφιεδ ωαστεσ (ΧΦΣΩ)* types of low-level radioactive wastes, the related Government and ministry ordinances for disposal have been established, and the related disposal facilities are operating. However, there are still other waste types that are manufactured by new methods and for which the regulatory guidelines and standards have not yet been established. For these types of waste, JNES has drafted regulatory guidelines and standards, submitted them to NISA, provided NISA with support in relation to the establishment of ministry ordinances, and confirmed that these types of waste met the regulatory guidelines and standards [3].

No regulatory guidelines or standards have been established under the ministry ordinances for large-sized metal wastes produced by dismantling of nuclear power stations and disposed of in near surface concrete pits, or very low-level non-solidified metal wastes which are disposed of in trenches. For these wastes, therefore, JNES is now earnestly conducting the necessary examination on the requirements in order to draw up regulatory guidelines and standards, and making the necessary review of various disposal confirmation methods. To accept the low-level radioactive wastes which will be returned from the overseas reprocessing facilities, JNES are also reviewing the methods for checking the compliance of the returned wastes with the regulatory guidelines and standards as well as the disposal of these types of wastes.

4.2. Intermediate Depth Disposal

Regulatory guidelines and standards such as the upper limit of concentration have been established under the related Government ordinance for the intermediate depth disposal of nuclear power plant wastes. For wastes from other fuel cycle facilities, however, no regulatory guidelines and standards have been established yet on the upper concentration limit or the depth of disposal facilities. NSC and the related

committees in the NISA are now seriously considering the establishment of these guidelines and standards. On the other hand, the operator have completed surveys of repository site, and published the results in their report. In this report, they concluded that they had found no problematic bedrock that would prevent a disposal facility from being constructed there.

JNES has studied the safety assessment techniques for disposal of core wastes at intermediate depth; particularly the safety assessment models developed in U.S.A. and European countries, and reviewed the safety assessment techniques, including safety assessment scenarios and models, in accordance with the risk-informed concept determined by NSC beforehand. JNES is now collecting and collating the data required to establish the regulatory guidelines and standards for the safety of radioactive waste disposal [4]. The Disposal Subcommittee of NSC is now discussing the dose criteria in accordance with the risk-informed concept, and JNES is also supporting this concept [5]. Under this concept, safety assessment scenarios are classified into 3 groups for nominal, unlikely, and very unlikely categories, based on the probability of occurrence and consideration of the potential risk. To establish the technical regulatory guidelines and standards for the safety of radioactive wastes, JNES is now considering safety maps represented by the safety performances of engineered and natural barriers, bearing in mind the need to ensure that the engineered and natural barriers will complement each other to achieve the predetermined total system performance [6] [7].

5. Geological Disposal

The Waste Safety Subcommittee of NISA is now considering what the safety regulation legislative system for geological disposal should be. In its draft report, the regulatory authorities are also required to review the reports prepared by operators on the final disposal implementation plan and the selection of sites for investigation, focusing the compliance the results with the requirements of the Law for Final Disposal of Specified Radioactive Waste and to provide guidelines showing how to carry out the investigations necessary for future safety assessments as well as the quality assurance related to investigations [8]. With the assistance of JNES, NISA is now considering the legislation in accordance with this report.

To achieve its first target of establishing a safety regulation system, JNES will draft the guidelines for preliminary surveys in cooperation with the other organizations supporting the establishment of safety regulations. As the coordinator of these supporting organizations, JNES also plans to conduct the following research:

- (1) To establish safety assessment techniques, JNES will attempt to establish an integrated modeling technique combining the geologic modeling technique with the mother rock region/engineered barrier modeling technique, which were developed by the research institutions supporting the establishment of safety regulations.
- (2) JNES will collect and improve FEP (Feature, Event and Process) data to establish the FEP database, which could be shared by all the research institutions supporting the establishment of safety regulations.
- (3) To confirm the reliability of the safety assessment techniques by the trial application of these techniques to the real geologic environment, and obtain, in the real environment, the knowledge of geological disposal technologies required to establish the technical standards for the design, construction

and operation of repositories, JNES will conduct research (such as real environmental testing to verify codes) by using the underground research facilities to be constructed under its deep geologic research facility project.

6. Conclusion

Some of the recent support activities of safety regulations carried out by JNES in the decommissioning, clearance, and radioactive waste disposal have been described here. The Radioactive Wastes Assessment Office of JNES is an organization that was established only about 2 years ago. However, its mission is now increasingly important. One of the reasons is that the establishment of the safety regulations system related to radioactive waste disposal has been delayed. Therefore, it is expected that all the organizations supporting the establishment of safety regulations will collaborate to conduct safety researches efficiently and effectively under the direction of NISA, and JNES will play an increasingly important role as the coordinator of these technically supporting organizations of safety regulations.

References

- [1]. Y. Iguchi, T. Baba and H. Kawakami, "Study for Nuclide Transfer of Particles Generated by Thermal Cutting", ICONE14-89139, 14th International Conference on Nuclear Engineering July 17-20, 2006, Miami, Florida, USA
- [2] M. Tachibana and T. Yamanaka, "Rules for clearance and their confirmation method in Japan", 4th Symposium Release of Radioactive Material from Regulatory Control, Hamburg, Germany, Mar. 2006
- [3] H. Kawakami, M. Kato and M. Furuya, "A Procedure for safety verification of low-level radioactive wastes" IAEA-CN-135/21, Oct. 2005
- [4] H. Kawakami, "The Current State-of-the-art of Probabilistic and Risk-informed Regulation for Radioactive Waste Disposal", the Atomic Energy Society of Japan, 22nd Backend Seminar, July 2006.
- [5] H. Kawakami, "Examples of Analyses on Typical Safety Scenarios for the Safety Assessment of Low-Level Radioactive Waste Disposal Facilities", Nuclear Safety Commission of Japan, Subcommittee on the Disposal of Low Level Radioactive Wastes, No. 6-1, Sep. 2006.
- [6] S. Suzuki, H. Aoki et al., "Considerations on the Barrier Performance Indicators of Engineered Barrier Systems for Radioactive Waste Facilities – 1. A consideration on Performance of Barriers for Facilities", CS05-015, Japan Society of Civil Engineering, Sep. 2006.
- [7] A. Hata, S. Suzuki et al., "Considerations on the Barrier Performance Indicators of Multiple Engineered Barrier Systems for Radioactive Waste Facilities – 2. Arranged Conditions and Safety Map of Disposal Facilities Constructed below the Generally Used Depth and Having the Specified Safety Performance", CS05-016, Japan Society of Civil Engineering, Sep. 2006.
- [8] Waste Safety Subcommittee, NISA, "Safety Regulation Legislative System for Geological Disposal of Radioactive Waste (Draft)" Sep, 2006

CHALLENGES IN INTRODUCING RISK INFORMED REGULATION IN JAPAN

Mamoru Fukuda, Haruo Fujimoto, Masahiro Yamashita, Masajiro Sugawara

Japan Nuclear Energy Safety Organization (JNES), Kamiya-cho MT Bldg. 4-3-20
Toranomon, Minato-ku, Tokyo, 105-0001, Japan

Abstract. Risk informed regulation (RIR) is being put into place to enhance the scientific rationality of the safety regulation in Japan. This paper, first, summarizes the background of the use of PSA in Japan and then describes challenges and roles of JNES.

1. Background

1.1. *Expectation to nuclear safety regulation with the use of “Risk information”*

To ensure the safety of nuclear power plants, safety assurance measures, such as “measures to prevent the occurrence of abnormalities, i.e. failures or trouble,” “measures to prevent abnormalities from escalating and developing into accidents,” and “measures to prevent release of radioactive materials,” are provided along the concept of defense in depth. In addition, assuming the occurrence of design base events, behaviour of nuclear plant facilities and influence to the environment of the facilities are evaluated in a deterministic manner to show the validity of the safety measures. It is said, however, that there remain following issues to enhance scientific rationality of current safety regulation:

- Even if high degree of public safety is ensured, it is difficult to answer the following questions from the public: what the safety level is and how much the residual risk remains.
- In the regulation and rules in each stages, how and what extent are the various uncertainties considered? It is difficult to show whether the safety margin is well-balanced or not.
- It is difficult to understand the significance of the alternatives for design and operation from the safety point of view.

Probabilistic safety assessment (PSA), on the other hand, is a technique that, allowing to take all possible accident sequences into consideration, analyzes and evaluates the occurrence frequencies of initiating events, such as abnormalities and failures, the failure probability of safety functions which can mitigate the influence posed by the events, and the progress and influence of events quantitatively, and thus evaluates the safety comprehensively based on the occurrence frequencies, the degree of influence, or the product of them, i.e. risk. Accordingly, because PSA can evaluate various kind of quantitative risk information which can not be achieved from the deterministic assessment, it can supply the information for the issues mentioned above.

Hence, it is expected that the safety regulations accompanied by use of “risk information” obtained from PSA, enhancing the understand of risk and concentrating on safety significant problems, complement the traditional deterministic safety regulation based on the defence in depth concept, establish the consistency of safety regulation from the risk point of view, and thus enlarge the scientific rationality of safety regulatory decisions.

1.2. *Application of “Risk information” to the nuclear safety regulation in Japan*

PSA technology for the nuclear power plant facilities had been developed from 1960s’ in the U.S.A. and the bases of the technology was establish in the reactor safety study (WASH1400) which was published in 1975. Application of “risk information” to the nuclear safety regulation has been investigated in Japan.

(1) Initial stage of use of “Risk information”

From the 1990s in Japan, regulatory body, JNES, research organizations, and industries have investigated the enhancement of PSA technology and the application of “risk information” obtained from PSA and accumulated the experiences through the realization of the accident management strategy and the evaluation of their effectiveness, the comprehensive safety assessments in the periodic safety review, and the evaluation of allowed outage time specified in the safety preservation rules.

(2) Systematic application stage of “Risk information” to safety regulation

In the 2000s, the Nuclear Safety Commission (NSC) in Japan established safety goals for nuclear facilities and the performance objectives for nuclear power plants, and issued “Basic policy of introducing the risk informed regulation” which shows a basic strategy to use risk information aiming for the enhancement of rationality, consistency, transparency and accountability of safety regulation, and the effective allocation of resources in safety regulation.

Nuclear and Industrial Safety Agency (NISA) declared that it will make investigation to use risk information widely to nuclear safety regulation and issued “Basic concept to apply ‘Risk information’ to nuclear safety regulation”[1], “Near-Term Implementation Plan for Utilization of ‘Risk Information’ in Nuclear Safety Regulation”[2], “High-level Guidelines for Utilization of ‘Risk Information’ in Safety Regulation for NPPs -Trial Use-”[3], and “PSA Quality Guidelines for NPP Applications -Trial Use-”[4].

Atomic Energy Society of JAPAN (AESJ) starts to make PSA related standards, i.e. procedure standards for level 1, level 2, and level 3 PSA during power operation, seismic PSA procedure standards, and the guidelines for the application of “risk information” as well.

Originated with the experiences of the falsification of inspection records done by Tokyo electric power company and the secondary system pipe rupture in Mihama nuclear power station unit 3 of Kansai electric power company, the introduction of the inspection system for the maintenance activities based on the maintenance programs and the establishment of the guidelines for the root cause analysis are being investigated.

2. Role of JNES in the initial stage for the application of “risk information” to nuclear safety regulation

2.1. Development of PSA methodology

JNES has been introducing and improving PSA methodologies developed in US. JNES has carried out Level 1 and Level 2 PSA for Japanese typical PWR and BWR plants based on the plant information presented by the licensees, and has accumulated the knowledge about “risk information” obtained from PSA, which includes insights on the uncertainty and the limits of the application,.

France has pointed out the importance of low power and shutdown (LPSD) operation to maintain the plant safety through LPSD PSA in late 1980s. Stimulated by this information, JNES has carried out LPSD PSA for Japanese typical PWR and BWR plants to comprehend their safety levels.

In general, PSA is a powerful tool to systematically evaluate the importance of incidents and accidents, JNES has expanded PSA models for eight Japanese typical PWR and BWR plants. Using those PSA models, JNES has conducted the accident sequence precursor (ASP) analysis for domestic and foreign accidents. Furthermore, since seismic-induced risk is dominant in Japan, JNES has started to develop the methodology for Seismic PSA. Also, JNES has started to develop the methodologies for Fire PSA and Flooding PSA.

2.2. Technical support to the regulatory review of PSA carried out by the licensees

NSC of Japan decided to introduce accident management based on PSA. Accordingly NISA asked licensees to carry out their Level 1 and Level 1+ PSA for power operation to all NPPs in Japan, and licensees submitted the results to NISA. JNES reviewed the adequacy of their PSA results, using the eight Japanese typical PSA models. In the same manner, JNES reviewed the adequacy of their voluntarily conducted LPSD PSA in a periodic safety review.

3. Role of JNES in Current Stage; Systematic Use of “Risk Information” in Safety Regulation

3.1. Development of Risk Informed Regulatory Framework

NISA, in corporation with JNES, developed “Basic Concept to Apply ‘Risk Information’ to Nuclear Safety Regulation” and “Near-Term Implementation Plan for Utilization of ‘Risk Information’ in Nuclear Safety Regulation”, etc. These documents compose the main part of the risk informed regulatory framework shown in the Fig.1.

“Basic concept to apply ‘risk information’ to nuclear safety regulation” contains (1) role of “risk information” in safety regulation, (2) application area and scope of “risk information”, (3) features, limitations and roles of “risk information”, (4) facets of utilization of “risk information”, (5) approach toward risk informed regulation, etc. JNES contributed technically to identify the potential risk informed applications, and to clarify the role, pattern and merit of utilizing risk information in the regulatory decision making, based upon the results and perspectives gained through applying “risk information” in the early stage, and reviewing the status of PSA methodology in Japan, the risk informed regulation in US, etc.

“Near-Term Implementation Plan for Utilization of ‘Risk Information’ in Nuclear Safety Regulation” describes near-term RIR application-selection criteria, application items in various areas, such as design, construction, operation and inspection areas, and the development of PSA methodology. NISA and JNES wrapped up the strategic plan through deliberation with people of experience or academic standing.

“High-level Guidelines for Utilization of ‘Risk Information’ in Safety Regulation for NPPs - Trial Use-” describes “fundamentals of utilization of ‘risk information’”, objectives and scope of high-level guidelines and so on. NISA and JNES discussed consistency with the current regulation principles, considerations to preserve defense in depth and so on. “PSA Quality Guidelines for NPP Applications - Trial Use-” describes elements of PSA quality and requirements. JNES, furthermore, cooperated with the AESJ to develop the PSA standards, which addressed to prepare the prescriptive requirements to assure the PSA quality.

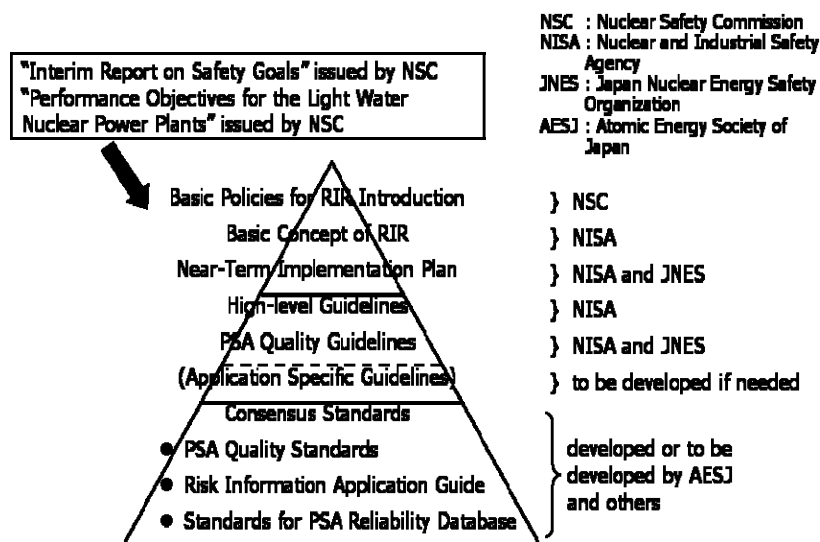


Fig. 1 Framework Utilization of “Risk Information” in Nuclear Safety Regulation

3.2. *Pilot Application and/or Implementation of Risk Informed Regulation*

JNES, together with NISA, has been conducting the application items identified in “Near-Term Implementation Plan for Utilization of ‘Risk Information’ in Nuclear Safety Regulation”, reflecting the experiences of PSA applications and considering the needs to apply “risk information”.

For example, the new inspection system pursues the enhancement of maintenance activities, reflecting individual plant features, ensuring the plant safety intensively through safety preservation activities and ensuring the licensees’ action to correct the nonconformity. JNES has been cooperating with the staff of NISA, to identify requirements to the maintenance program under the framework of the new inspection policy, proposing to utilize “risk information” in order to (1) confirm the adequacy of the safety significance of each structure, system or component assigned by licensees for maintenance, (2) confirm the adequacy of the configuration control in the maintenance schedule developed by licensees, (3) identify inspection items, focused on safety significant activities conducted by licensees, including activities for the maintenance, (4) select performance indicators, and (5) develop the threshold or the quantitative criteria for measuring the plant performance level.

JNES also performs the pilot application to confirm the appropriateness of the safety preservation rule (e.g., allowed outage time, etc.), and to apply “risk information” in assessing the safety information, such as accidents, incidents etc. in nuclear power plants. JNES will confirm the adequacy of the “residual risk” evaluated by licensees. In these applications, the standards and guidelines are expected to be developed, in order that the regulatory staff could be apply concretely the risk informed decision making. NISA and JNES will revise near-term implementation plan once every year, based on regulatory needs and the state-of-the-art PSA methodology.

4. Future Role and Approach

Roles of JNES in this stage are limited to (1) develop PSA technique (methodology and data, etc.) in preparation for the activities of regulatory side in the application of “risk information” to nuclear safety regulation, to (2) evaluate the adequacy of Level 1 and Level 1+ PSA of the licensees comparing with independently conducted JNES’s PSA, and to (3) evaluate the safety importance of domestic and foreign accidents and the adequacy of prevention counter measures using Level 1 PSA. In this stage, JNES has already reached a technical level of being able to comprehend the characteristics of all NPPs in Japan from the viewpoint of “risk information.”

In the current stage, JNES is expected to perform the role of regulatory staff partially, besides the role of technical staff to develop and prepare the PSA methodology. It becomes one of important roles of JNES, to technically support the development of guidelines and manuals for the regulatory decision making in various areas, such as the examination and inspection, where “risk information” is utilized to make the regulatory decision for the licensees’ applications, and to comprehensively assess the maintenance activities of individual plants.

On the other hand, JNES has the important role to enhance and assure the quality of PSA methods and database, through cooperating with the regulatory organization and/or the academic authorities. Furthermore, JNES is still expected to enhance the PSA methodologies including those for the earthquake, internal fire, internal flooding and other external events, considering that PSA could supply the quantitative information broadly in the regulatory decision making process, besides the traditional deterministic information.

REFERENCES

- [1] NISA, “Basic Concept Apply ‘Risk Information’ to Nuclear Safety Regulation”, May 2005
- [2] NISA and JNES, “Near-Term Implementation Plan for Utilization of ‘Risk Information’ in Nuclear Safety Regulation”, May 2005
- [3] NISA, “High-level Guidelines for Utilization of ‘Risk Information’ in Safety Regulation for NPPs –Trial Use–”, April 2006
- [4] NISA and JNES, “PSA Quality Guidelines for NPPs Applications –Trial Use–”, April 2006

Concept of Technical Support Organization for Nuclear Activities in Indonesia

Anhar R. Antariksawan

Center for Reactor Technology and Nuclear Safety
National Nuclear Energy Agency of Indonesia (BATAN)
Kawasan Puspiptek Serpong Gd. 80, Tangerang 15310, Indonesia
e-mail: anhar@batan.go.id

Abstract. According to the nuclear energy act No. 10/1997, the promoting and regulating functions of utilization of nuclear energy which are previously conducted by single body so-called BATAN, is separated. The regulating function is conducted by a regulatory body namely BAPETEN, and promoting function in the field of applications of nuclear energy is vested in the promotional body, which is BATAN. On the other hand, for supporting the task of regulatory body, the existence of a technical support organization (TSO) is believed indispensable, especially in case of detailed assessment of technical problems. Conceptual arrangement of technical support system is proposed in this paper. Based on the experiences of developed countries and national conditions, it is proposed that TSO might be independent of both regulatory body and operating organization. That independency is also expected to increase transparency. The embryo of this TSO is resources in BATAN and also in several universities.

Key words: TSO, nuclear energy, regulatory

1. Introduction

In Indonesia, the activities in the field of nuclear science and technology were started by the establishment of National Committee for Investigation of Radioactivity. The main duty of the committee was to assess the impact of radioactive fall out as results of nuclear weapon testing in the pacific region during the year fifties. In the beginning of 1960, one research reactor was built to accelerate the research and development of nuclear science and technology in Indonesia. Then, the committee was changed to Atomic Energy Board. In 1964, the government established National Atomic Energy Agency, so-called BATAN, to replace the Atomic Energy Board by enacting Atomic Energy Act No. 31, year 1964. Based on this act, BATAN is the only agency who is responsible to perform, regulate and control utilization of nuclear energy for public safety, health and welfare. The implication of this act is unification of promoting function and regulating function in one organization.

As the activities in utilization, research and development of nuclear science and technology have been developed from time to time, and also regarding the need of regulating function independency, the new Nuclear Energy Act No. 10/1997 was enacted in 1997 [1]. In this act, it is clearly endorsed the separation of promoting function (including research and development), that is performed by so-called executing organization, and regulating function which is conducted by a regulatory body. Then, in 1998, the government of Indonesia established a regulatory body which is called BAPETEN. At the time of its establishment, the initial main element (i.e. employee and facilities) of BAPETEN came from regulating division of BATAN. On the other hand, based on Presidential Decision No. 103 year 2001 [2], BATAN becomes an executing organization with the main function is to promote the nuclear science and technology through research, development and dissemination of its results.

As the activities developed, the number of object under regulatory control increases, which includes hospitals, industries, research reactors and fuel cycle facilities. The development of the activity might continue with the projection of the introduction of nuclear power plant in the national electricity generation system. As this development challenges the regulatory activities, then the support dealing with the technical aspects is needed, especially when the safety is concerned. At present, there is no one specific organization dealing with such tasks. This paper describes the concept of technical support organization (TSO) in Indonesia and the challenges that might be faced. The concept proposed is based on the current practices and the existing organizational structures, both of the regulatory and operating organization, and also the foreseen development of nuclear energy application in Indonesia.

2. Organizational Structure of Regulatory and Executing Bodies

Nuclear Energy Act No. 10/1997 gives BAPETEN mandate to establish regulation, issue licenses, perform inspection and undertake necessary enforcement in order to ensure the compliance of the nuclear energy operators to safety regulations and requirements [3].

BAPETEN which is an independent regulatory body has responsibility to assure that any activity related to the use of any nuclear energy is obligated to maintain the safety, security, and peace, as well as the health of the workers and the public, and also the protection of the environment. These are administered by:

1. Drafting and establishing nuclear safety regulations
2. Controlling nuclear installations and nuclear materials through licensing and inspection systems that covered all stages of Nuclear Power Plant (NPP) establishment (from site selection to decommissioning stages);
3. Controlling the use of radioactive materials and other radiation sources through licensing and inspection systems.

To perform these tasks, several directorates and centers are established in the BAPETEN's organizational structure as shown in Figure 1.

BATAN is established as the national effort to maximize the benefits of the use of nuclear energy. The activities in BATAN include the research and development of nuclear science and technology and its application for public health and welfare.. In performing its task, BATAN operates several nuclear facilities, including three research reactors, fuel fabrication facility and waste management facility. Beside of the research and development, BATAN has also a function to promote the nuclear science and technology to the public through, for example, dissemination of the research and development results. Figure 2 shows the BATAN's organizational structure.

3. Concept of Technical Support Organization

As shown in the structure organization of BAPETEN, there is two centers under Deputy for Nuclear Safety, Assessment have the responsibility to assess the radiation and nuclear safety, i.e. Center for Regulatory Assessment of Nuclear Installation and Nuclear Materials, and Center for Regulatory Assessment of Radiation Facilities and Radioactive Sources. Their scope of activities is intended to support the main function of BAPETEN comprising development of regulation, licensing and inspection. Their supports concern mainly on providing scientific judgment for technical problem encountered during the performance of its function. Considering their responsibility, these two centers could be considered as an internal TSO. In current practices, due to limitation of its resources and to

obtain the more comprehensive assessment results, those two centers call for external experts coming from various centers in BATAN or from the universities.

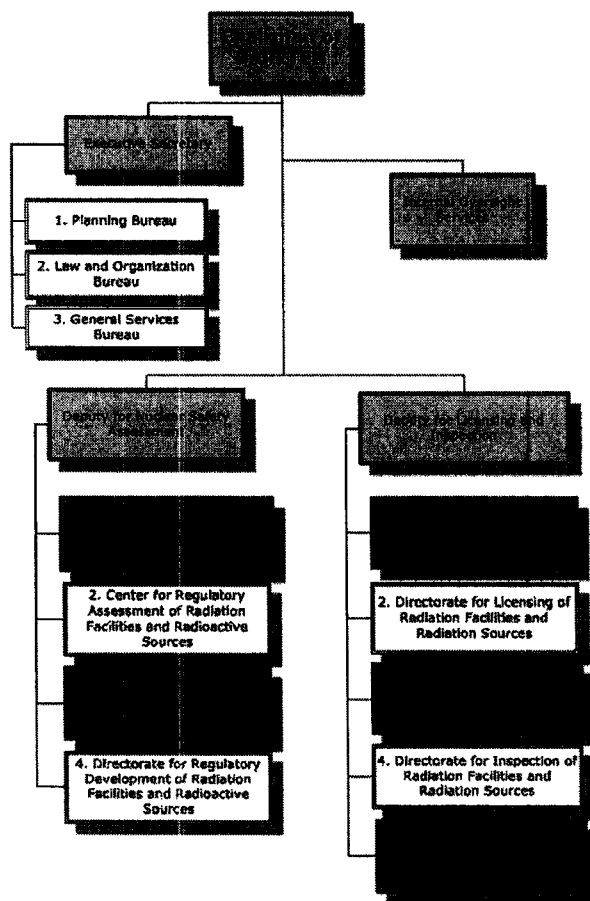


FIG. 1. Organizational structure of BAPETEN [3].

As shown in the organizational structure (see Fig. 2), the R&D activities in BATAN cover the basic and applied researches and also in the engineering and application development. Concerning the nuclear and radiation safety, there are the centers such as PTRKN and PTKMR, respectively. On the other hand, to support the introduction and development of nuclear power, there are several centers such as PPEN, PTRKN, PTBN, PPGN, PTLR and PRPN.

Regarding the use of nuclear energy as an option for primary energy source for electricity, the introduction of NPP in Indonesia is aimed to reach an optimum energy mix considering cost, environment, and to relieve the pressure arising from increasing domestic demand for oil and gas. It is enforced by the Presidential Decree Number 5 year 2006 on National Energy Policy that specifies the share of new and renewable energy, especially: biomass, nuclear, hydro, solar and wind in the national energy mix should reach more than 5% in the year 2025. The optimized energy mix scenario shows that the nuclear energy (from nuclear power plant, NPP) is expected to contribute about 4-5% of national electricity generation, i.e. 4000 MWe approx. The first NPP of 1000 MWe power is assumed could be operated in 2016.

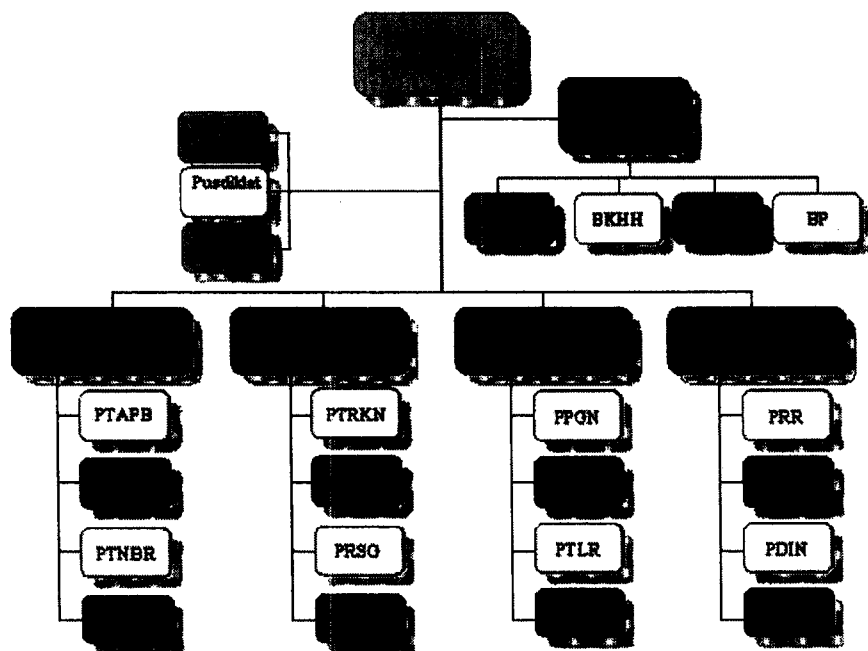


FIG. 2. Organizational structure of BATAN.

Based on Nuclear Energy Act, the development, operation and decommissioning of NPP shall be performed by state company, cooperatives or any other private company, BATAN has been prepared to play a role as a TSO, which will give technical support to both the regulatory body and operating organization. Figure 3 shows the concept of organizations involving in the NPP Project. If the reactor technology and safety is concerned, PTRKN and PPEN could be expected to be major counterparts. As to support the man power needed for the project, several centers in BATAN dealing with research reactors, such as PTAPB, PTNBR, PRSG and Pusdiklat, could support by providing education and training in nuclear engineering fundamental knowledge. On the other hand, it is mentioned in Nuclear Law that BATAN is responsible for fuel cycle activities, and in the organizational structure of BATAN, this activities are leaded by PTBN, PPGN and PTLR.

In the long term, assuming the nuclear activities continue to develop in Indonesia, the establishment of an independent TSO which is separated from both BAPETEN and BATAN should be considered to have a more independent technical support to regulatory body and the utilities. If it should be established, the embryo of this organization could be the resources from BATAN, BAPETEN and also universities. However, to optimize the resources, if the R&D is needed, TSO could still cooperate with BATAN or the universities.

4. Conclusions

The nuclear activities in Indonesia develop from time to time. At present, nuclear regulation is conducted by BAPETEN. To support its regulation function, BAPETEN has internal technical support directorates, only in some cases it calls for support from other institutions, such as BATAN or the universities. In the middle term, to anticipate the introduction of first NPP, BATAN has a role as TSO, both to the utility and BAPETEN. In the long term, when the nuclear activities continue to develop, the establishment of an independent TSO could be considered with the embryo comes from BATAN, BAPETEN and the universities.

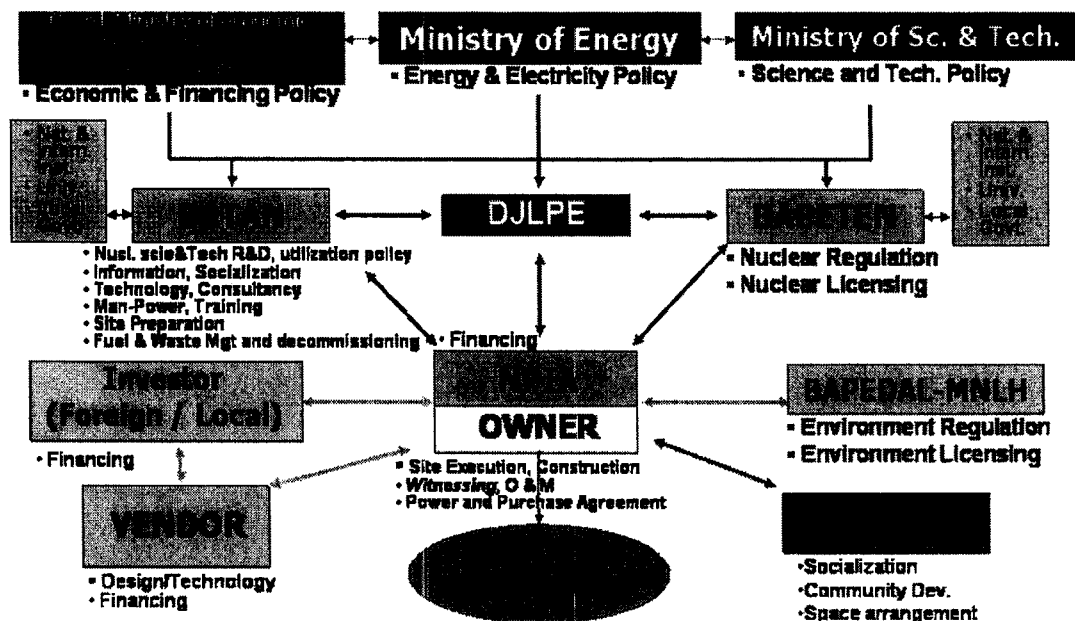


FIG. 3. Proposed NPP Organization.

Abbreviations:

BAPEDAL	: Environmental Impact Controlling Agency
BKHH	: Bureau for Cooperation, Legal and Public Relation
BP	: Bureau for Planning
BSDM	: Bureau for Human Resources
BU	: Bureau for General Affaires
DJLPE	: Directorate-General of Electricity and Energy Utilization
IPP	: Independent Power Producer
PATIR	: Center for Application of Radiation and Isotope Technology
PDT	: Basic Research and Application
PHLPN	: Utilization of R&D Results and Public Information of Nuclear Science and Technology
PKTN	: Center for Nuclear Technology Partnership
PPEN	: Center for Development of Nuclear Energy
PPGN	: Center for Development of Nuclear Geology
PPIN	: Center for Development of Nuclear Informatics
PRPN	: Center for Engineering and Nuclear Components
PRR	: Center for Radioisotope and Radiopharmaceutical
PRSG	: Center for Multi Purpose Reactor
PSJMN	: Center for Standardization and Quality Assurance
PTAPB	: Center for Accelerator and Material Process Technology
PTBIN	: Center for Nuclear Industry Material
PTBN	: Center for Nuclear Fuel Technology
PTDBNR	: Development of Nuclear Fuel Cycle and Engineering
PTEN	: Development of Nuclear Energy and Technology
PTKMR	: Center for Radiation Safety Technology and Metrology
PTNBR	: Center for Nuclear Material and Radiometry

PTLR : Center for Radioactive Waste Technology
PTRKN : Center for Reactor Technology and Nuclear Safety
Pusdiklat : Center for Education and Training

References

- [1] ---, "Nuclear Energy Act", Act Number 10 Year 1997, 1997.
- [2] ---, "Position, Task, Function, Right, Organization Structure, and Work Procedure of Non-Department Government Agency", Presidential Decision Number 103 Year 2001, 2001.
- [3] BADAN PENGAWAS TENAGA NUKLIR, <http://www.bapeten.go.id>, 2006.

Role of Technical and Scientific Support Organization In Indonesian Regulatory Body

Yusri Heni N.A., Amin S. Zarkasih, Liliana Y.P., Salman S.

Center for Regulatory Assessment of Nuclear Instalation and Nuclear Material, Nuclear Energy Regulatory Agency (BAPETEN), Jakarta, Indonesia

Presented by Yusri Heni N.A.

Abstract. Indonesian Nuclear Energy Regulatory Agency (BAPETEN) has the function in controlling the utility of nuclear energy through regulation, licensing and inspection, with the aim, interalia, to ensure the welfare, the security and the peace of people, to assure the safety and the health of workers and public, and the environmental protection, and to prevent diversion of purpose of the nuclear material utilization (Article 14 and 15 of Act no 10, 1997 on Nuclear Energy). The role and quality of technical and scientific expertise in supporting regulatory systems are importance increase the effectiveness and public confidence. The Center for Regulatory Assessment of Nuclear Instalation and Nuclear Material and Center for Regulatory Assessment of Radiation Facilities and Radioactive Sources as part of BAPETEN organization has a function as technical and scientific support for regulatory systems. The purpose of this function is to provide technical and scientific basis for decisions and activities regarding nuclear and radiation safety during regulatory processes, such as in the developing and establishing regulation, technical verification for licensing, assesment of inspection funding and enforcement. In order to meet the quality and effectiveness of technical and scientific result activity, those two centers for regulatory assesment used internal and eksternal technical experts and joint cooperation with universities, research institutes or laboratories. The development of technical and scientific strategic planning in enhancing nuclear and radiation safety is done by the following increasing of : Human resources and expertise by internal and external training or on the job training; number for computer code to perform safety analysis, capability and quality for review and assesment, nasional and internasional cooperation , etc

1. INTRODUCTION

At the present Indonesia has no nuclear power plant in operation yet, although it is expected that the first nuclear power plant will be operated and commercially available in around the year of 2016 to 2017 in Muria Peninsula. There are only three research reactors, one nuclear fuel fabrication plant for research reactors, and one experimental fuel fabrication plant for nuclear power, one isotop production facility and some other research facilities. However, radioisotopes and radiation sources are being extensively used in various developments such as in medicine, industry, mining, agriculture, and research. In anticipation of expansion of the nuclear programme in Indonesia, the Indonesian government enacted the Law No. 10 / 1997 on nuclear energy. The Law addresses several key requirements for the successful conduct of Indonesia's nuclear industry, including the establishment of both an executing body responsible for nuclear research and development, mining and processing nuclear fuel and material, production of radio-isotope and management of radioactive waste and independent nuclear regulatory body, which will have the power to regulate, to license and to inspect all facets of any activity using nuclear energy. It is also sets out the basic principles for regulating practices in the application of nuclear energy, the basic arrangements for managing and disposing of radioactive wastes and the allocation of liability of nuclear damage. The law will be implemented through the application of further government regulation which will be further established.

2. REGULATORY FRAMEWORK

The Indonesian Nuclear Energy Law, separates fully the promotional and regulatory functions in accordance with the article 3 and 4, and it establishes the regulatory body for control of the application of all nuclear energy through regulations, licensing and inspection. The regulatory body, Badan Pengawas Tenaga Nuklir (BAPETEN) . or Nuclear Energy Regulatory Agency , was then established by Presidential Decree No 76 / 1998 in May 1998 which was revised by Presidential Decree No103 / 2001 .

Utilization of nuclear energy . as stipulated in Nuclear Energy Law is defined as any activity related to nuclear energy utilization that includes research, development, mining, fabrication, manufacturing, production, transportation, storage, transfer, export, import, decommissioning and radioactive waste management to enhance people's welfare.

The basic principles of nuclear energy regulation practices in Indonesia set out in the Nuclear Energy Law provide that the control of nuclear energy application is aimed to :

- (a) Assure the welfare, security and peace of the people;
- (b) Assure the safety and health of workers and the public and protection of environment;
- (c) Maintain law enforcement in implementation of any nuclear energy application;
- (d) Increase legal awareness of the user to promote the creation of safety culture in nuclear field;
- (e) Prevent unauthorised changes in the purpose for which nuclear materials are used; and
- (f) Promote and assure the maintenance of worker discipline in the application of nuclear energy.

Any activity related to the application of nuclear energy is required to be conducted in manner which observes safety, security and peace, and protects the health of workers and the public and the environment.

BAPETEN is established as a governmental agency, under and directly responsible to the President of the Republic of Indonesia. The BAPETEN has the following functions :

- (a) The rulemaking of national policy in the field of the control of nuclear energy utilization;
- (b) The planning of national programme in the field of the control of nuclear energy utilization;
- (c) The guidance and rulemaking in the implementation of the nuclear safety, radiation safety, and safeguards assessments;
- (d) The implementation of licensing and inspection at the developments and operation of nuclear reactor, nuclear installation, nuclear material facility, radiation source, and development of nuclear preparedness;
- (e) The implementation of cooperation in the field of the control of nuclear energy utilization with the government agencies or other organizations either internally or externally to the Government of Indonesia;
- (f) The implementation of safeguards and state's system of accounting for and control of nuclear material (SSAC)
- (g) The implementation of the guidance and counseling for effort that related to the safety and health of worker and the people, and effort of environmental conservation;

In executing the three main activities in controlling of utilization of nuclear energy , Bapeten requires to execute activity of review and assessment and research and development on nuclear safety and radiation safety as scientific justification in determining the safety requirement which is put in regulation, licensing and inspection. Through the technical and scientific activities, all activity on controlling nuclear energy have been executed on the basis of correct scientific assessment for assure that all utilization of nuclear energy is peaceful to worker, society and environment.

3. TECHNICAL AND SCIENTIFIC ORGANIZATION IN BAPETEN

The organization structure of BAPETEN, besides the three main functions of regulation, inspection and licensing, it also provides with the internal technical and scientific support functions. Those additional function executed by :

The Center for Regulatory Assesment of Nuclear Instalation and Nuclear Material has the function for executing the technical and scientific support to conduct safety analysis as part part of assesment and review and has the function to conduct R&D in the field of nuclear safety of nuclear instalation and nuclear material, for example : Nuclear Power Plant, Research reactor, Fuel cycle installation.

The Center for Regulatory Assesment of Radiation Facilities and Radioactive Sources has the function for executing the technical and scientific support to conduct safety analysis as part part of assesment and review and has the function to conduct R&D in the field of radiation safety for radiation facilities and radioactive source.

Directorat for Technical Support and Emergency Preparedness has the function for executing emergency preparedness and technical support in preparing technical equipments for inspection and assesment.

The purpose of this function is to provide technical and scientific basis for decisions and activities regarding nuclear and radiation safety during regulatory procceses, such as in developing and establishing regulation, technical verification for licensing, assesment of inspection funding and enforcement.

Role and quality of technical and scientific expertice in supporting main function of BAPETEN (regulation, licensing and inspection) are importance in increasing quality, efficiency, effectiveness of regulatory body and public confidence.

In order to meet the quality and effectiveness of technical and scientific result activity, the Center for Regulatory Assesment of Nuclear Instalation and Nuclear Material and Center for Regulatory Assesment of Radiation Facilities and Radioactive Sources used internal and eksternal technical experts and joint cooperation with universities and research institutes or laboratories such as :

- (a) Bandung Technology Institute (for nuclear safety)
- (b) Gajahmada universities (for nuclear safety)
- (c) Indonesian University (for nuclear safety)
- (d) Reactor safety technology research center (for radiation safety)
- (e) Centre for Standarization and Research of Radiation safety (for radiation safety)

The development of technical and scientific strategic planning in enhancing nuclear and radiation safety is done by the following increasing of :

- (a) Human resouces and expertise by internal and external training or on the job training;
- (b) Number for computer code to perform safety analysis,
- (c) Capability and quality for review and assesment,
- (d) Nasional and Internasional cooperation

To enhanced the role of technical and scientific support unit with the other unit of regulation, licensing and inspection, need the enhanced the coordination, integration, and synchronization of the program activity through radiation safety forum and nuclear safety forum .

4. CONCLUSION

Nuclear energy regulatory agency (NERA) or BAPETEN started to function since 4 january 1999, to conduct the control of nuclear energy utility through regulation, licensing, and inspection . As stipulated on the organization structure, BAPETEN has internal technical and scientific function which executed by 2 center and 1 directorate that is The Center for Regulatory Assesment of Nuclear Instalation and Nuclear Material , Center for Regulatory Assesment of Radiation Facilities and Radioactive Sources, and Directorat for technical support and emergency preparedness . The purpose of this function is to providing technical and scientific basis for supporting decisions and activities regarding nuclear and radiation safety during regulatory procceses, such as in developing and establishing regulation, technical verification for licensing, assesment of inspection funding and enforcement.

REFERENCES

- [1] Act No. 10 / 1997 on Nuclear Energy
- [2] BAPETEN Chairman Decree No. 1 rev. 2 / 2004 on Organization of BAPETEN
- [3] Presidential Decree No. 76 / 1998 on BAPETEN
- [4] Presidential Decree No. 103 / 2001 on Non Department Organization

Indian Real time Online Decision Support System for Offsite Nuclear Emergency

A. Vinod Kumar¹, R.B. Oza¹, P. Chaudhury², M. Suri², S. Saindane², K.D. Singh³,
P. Bhargava³, V.K. Sharma³

¹Environmental Assessment Division,
Bhabha Atomic Research Centre, Trombay, Mumbai 400085, India

²Radiation Safety Systems Division,
Bhabha Atomic Research Centre, Trombay, Mumbai 400085, India

³Health Physics Division,
Bhabha Atomic Research Centre, Trombay, Mumbai 400085, India

Abstract. A real time online decision support system as a nuclear emergency response system for handling offsite nuclear emergency at the Nuclear Power Plants (NPPs) has been developed by Health Safety & Environment Group, Bhabha Atomic Research Centre (BARC), Department of Atomic Energy (DAE) under the frame work of “Indian Real time Online Decision Support System “IRODOS”.

1. Introduction

A Decision Support System (DSS) intends to provide comprehensive and timely information to the response team handling a nuclear emergency arising from a nuclear accident. The development of decision support systems worldwide is based on lessons learnt from the historical Chernobyl accident. Although the accident in a RBMK (Acronym for Russian - Reaktor Bolshoy Moshchnosti Kanalniy) reactor can hardly be taken as a benchmark for reactor safety, the environmental releases from the accident have nevertheless led to the most important improvements in the field of off-site emergency management.

Although India was not significantly affected by the fallout from the Chernobyl accident, it has drawn its lessons from the experience of the European countries and has augmented its emergency preparedness. Online environmental radiation monitoring network distributed throughout the country, independent and satellite based communication network, computerized on-line plant information system connecting all NPPs etc. were taken up in phased manner in this process. In view of India's rapidly expanding nuclear power program and the introduction of large capacity units, it was considered imperative to put in place a DSS for nuclear emergencies at all nuclear power plant (NPP) sites to assist off-site emergency management under the frame work of “Indian Real time Online Decision Support System “IRODOS”. The salient features of IRODOS system developed and operational are:

- a) 72 hours meteorological and radiological forecast with hourly resolution and update every 24 hours.
- b) Results available for a region of 75 km radius around Nuclear Power Plants with a spatial resolution of 1 km x 1 km.
- c) State of the art weather prediction, dispersion modeling techniques and radiological dose calculations.
- d) Advanced detection and communication network for sensing and assessment of accidental releases.
- e) User friendly visualization of results on a Geographical Information System (GIS).
- f) Storage of various databases required for handling emergency
- g) System operational permanently on a real time online basis.
- h) Live display at various places like control room, emergency response centre, crisis management group, offices of senior decision makers etc.

2. Present IRODOS System

The system in its present form gets 72 hours forecasted Numerical Weather Prediction (NWP) from mesoscale weather forecast model MM5 (Mesoscale Model version 5), operational at National Centre for Medium Range Weather Forecasting, NOIDA, India. The NWP is available in two spatial and temporal resolutions. One is in a grid size of about 30 km x 30 km over the Indian domain covering about 4000 km x 4000 km and a vertical height of about 15 km with a temporal resolution of 12 hour. The second one is in a grid size of 10 km x 10 km covering a horizontal region of 150 km x 150 km and a vertical height of about 15 km over each of the Indian NPP sites with a temporal resolution of one hour.

The coarser resolution NWP data is used in driving regional scale atmospheric dispersion model to simulate the transport and deposition of various radionuclides in case of a large scale nuclear disaster in a grid size of 30 km x 30 km in the Indian domain. The finer resolution NWP data is used in driving atmospheric contaminant dispersion model RIMPUFF (Riso Mesoscale Puff Model) to simulate the transport and deposition of various radionuclides in case of an accident at NPP in a grid size of 1 km x 1 km with a time resolution of 1 hour upto a radial distance of 75 km from the reactor centre. These results are used in calculating the radiological doses received by the population through various intake pathways using COSYMA (Code SYstem from Maria), a radiological dose code, and predicts the optimum countermeasures based on avertable dose concept. These results are displayed on a GIS. The various data bases/layers available in GIS are city and village boundaries, hospitals, schools, police and fire stations, sheltering and rallying points, vegetation cover and live stocks, transportation, road network etc.

The system in its normal operation runs with a high release term (fictitious source term) to simulate a beyond design based accident (BDBA) scenario with all counter measure options activated. An accident/event is sensed by IRODOS system using the NPP status sensors and/or from the field environmental gamma radiation monitors located around each NPP. Indigenously developed, solar powered environmental radiation monitors (ERMS) are installed around each NPPs, to sense an accident. These ERMS are placed in approximately two concentric rings, nearer one mainly to respond to ground releases and the farther one to elevated releases. Data from these monitors are continuously received and updated at the IRODOS centre using GSM (Global System for Mobile communication) based wireless data communication system, inbuilt in this system.

Once an event/accident is sensed, IRODOS system switches over to an emergency mode. It calculates the likely source term based on the ERMS readings using inverse calculations or from the NPP status data. The atmospheric concentration and dose contours are updated based on this source term for early phase action. The entire dispersion and dose calculation with the new source term is activated along with the estimation of optimum counter measures, for later phase decisions.

The system with its 72 hour meteorological, radiological and counter measure forecast, will guide the decision makers in arriving at optimum counter measures through various visual and query supports to minimize the radiological impact to the public during an offsite nuclear emergency.

Acknowledgement: The project is a coordinated effort of various divisions of Health, Safety & Environment Group (HS&EG) of Bhabha Atomic Research Centre (BARC), Mumbai, India. Authors duly acknowledge the guidance and motivation provided by Shri. H.S. Kushwaha, Director, HS&EG; Dr. A.K. Ghosh, Head, RSD, Shri. M.L. Joshi, Head, HPD; Dr. D.N. Sharma, Head, RSSD; Shri. V.D. Puranik, Head, EAD; Shri. C.K.G. Nair, Head, ESNS and Dr. Pradeep Kumar, Head, ERSM. The efforts and support extended by Shri. M.P. Ratheesh, Shri. A. Awasthi and Ms. P. Indumati of EAD; Dr. D. Dutta, Shri. S. Anand and Smt. S. Chitra of HPD; Shri. V.M. Shanware, Shri. P.K. Sharma and Shri. B. Ghosh of RSD; Shri. Rajvir Singh of RSSD and the continued operational support from Computer Division, BARC, Nuclear Power Corporation of India Limited and National Centre for Medium Range Weather Forecasting, NOIDA is duly acknowledged.

CNWRA Assistance to U.S. Nuclear Regulatory Commission: Contributions to Regulatory Science¹

Budhi SAGAR and Wesley C. PATRICK

Center for Nuclear Waste Regulatory Analyses

Southwest Research Institute®

P.O. Drawer 28510

San Antonio, Texas 78228-0510, USA

bsagar@swri.org

Abstract. The Center for Nuclear Waste Regulatory Analyses (CNWRA) was established by the United States Nuclear Regulatory Commission (USNRC) in 1987 as an independent technical and scientific support organization to help USNRC fulfill its responsibilities under the Nuclear Waste Policy Act (NWP) related to a potential repository at Yucca Mountain, Nevada, and interim storage facilities for spent nuclear fuel and high-level radioactive waste. CNWRA has assembled and retained a highly qualified work force, together with appropriate laboratory, field, and computing facilities, to provide comprehensive long-term support to USNRC for its regulatory activities.

1. Introduction

The CNWRA was established by USNRC as a Federally Funded Research and Development Center with the specific mission of providing scientific and engineering support focused on high-level nuclear waste management. Although it is an independent business entity, CNWRA functions as an operating division of its larger parent—Southwest Research Institute, a nonprofit research company with an established infrastructure. Organizational attributes of CNWRA that are essential for its successful support of USNRC include (i) being independent and free from the potential for any conflict of interest, (ii) being competent and capable of providing consistently high-quality support, (iii) having longevity to assure continuity of support and a “corporate memory,” (iv) complementing USNRC staff to avoid gaps or overlaps in technical expertise, and (v) having clear roles and responsibilities.

2. Role of Independent Scientific and Engineering Analyses

CNWRA roles and responsibilities include providing research and technical assistance, developing technical bases for regulations and guidelines, reviewing applicant’s safety analyses, providing hearing support, enhancing public outreach and communications, and providing technical advice. In each area, independent scientific and engineering analyses have been important to the USNRC regulatory process. A few examples illustrate some of these roles.

2.1. Development and Implementation of Regulations and Guidance

CNWRA helped USNRC develop regulations applicable to the potential repository at Yucca Mountain, Nevada [1], and preparing formal guidance [2] on how the USNRC staff will review and evaluate a license application for the repository. The USNRC staff conducted scoping studies to build confidence that the regulations could be effectively implemented and the review guidance would result in a consistent, technically sound, and comprehensive safety evaluation report.

¹ This paper describes work performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA) for the United States Nuclear Regulatory Commission (USNRC) under Contract No. USNRC-02-02-012. The activities reported here were performed on behalf of the USNRC Office of Nuclear Material Safety and Safeguards, Division of High-Level Waste Repository Safety. This paper is an independent product of CNWRA and does not necessarily reflect the view or regulatory position of USNRC.

The regulations [1] for the potential repository establishes (i) an all-pathways, mean annual dose criterion, (ii) a human intrusion criterion, and (iii) groundwater protection criteria. The United States Department of Energy (USDOE) is responsible for presenting its safety case in a license application; for that purpose, it has developed a computer code to analyze the performance of the repository system. Likewise, the USNRC and CNWRA staff developed their own Total-system Performance Assessment (TPA) computer code [3] in an iterative manner to support development of its regulation, enhance staff expertise, and risk-inform its work. Figure 1 illustrates an example calculation using the TPA code.

2.2. Evaluation of the Relative Importance of Factors Affecting Repository Performance

To effectively and efficiently focus efforts, both developers and regulators of geologic repositories must understand the relative importance of the factors affecting performance. In the U.S. program, this focus is fostered by the risk-informed, performance-based framework of the USNRC regulations and facilitated by application of both process-level (i.e., subsystem-level) and total-system analyses.

Fundamental to the consideration of locating a geological repository at Yucca Mountain is the notion that waste packages would remain relatively dry for long periods in the hydrologically unsaturated rocks [4,5]. The potential for salts in groundwater and atmospheric dusts to accumulate on waste packages and create conditions that could foster localized corrosion led CNWRA to independently examine the deliquescence point of solutions that could contact waste packages [Figure 2].

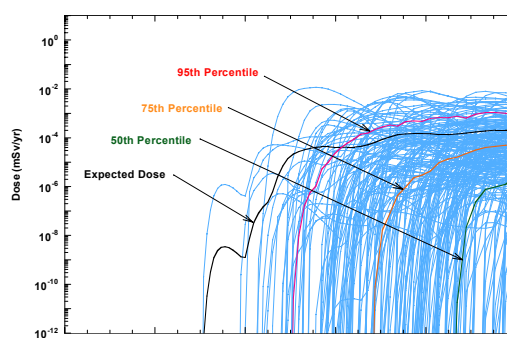


FIG. 1. Individual dose estimated for undisturbed conditions with USNRC–CNWRA TPA code. Each Monte Carlo realization is shown with various percentiles and the mean. The spread represents the effect of parameter uncertainties.

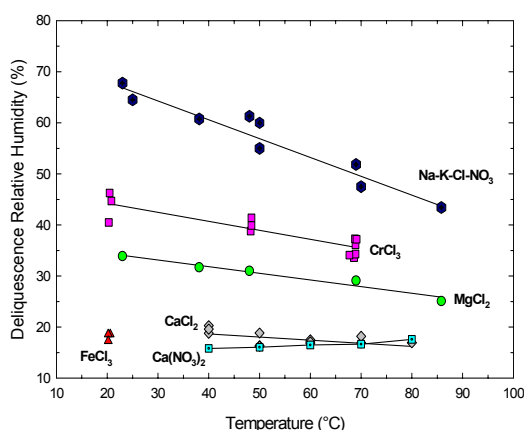


FIG. 2. Relative humidity in the presence of salts as a function of temperature. Relative humidity can affect potential onset of localized corrosion.

Results of the deliquescence study provided the in-depth understanding needed to evaluate USDOE studies, assessed the factors affecting the magnitude of the potential effect, and identified the presence of chemical species that could mitigate localized corrosion. These results allowed staff to critically assess the likelihood of localized corrosion in the presence of deleterious and effect-mitigating chemical species.

Relative importance of major repository subsystems down to individual radionuclides can be evaluated. For example, independent analyses examined the relative importance of waste packages and drip shields (designed to prevent infiltrating water from contacting the waste package at high temperatures). Using the best available information about the natural system and proposed repository

design [6,7], a 350-realization run of TPA estimated the basecase dose under three scenarios [Figure 3]. The results illustrate how these components affect when contaminants begin to reach the accessible environment and the peak dose to a receptor in the accessible environment.

A similar evaluation of relative contributions of various radionuclides to receptor dose showed that more than 90 percent of the estimated dose results from only three radionuclides: Tc-99 (48%), I-129 (24%), and Np-237 (19%). The independent study also provided important insight into why these radionuclides dominate dose estimates (i.e., long life and low retardation) and what repository system components contribute to total-system results. Armed with these insights, the regulator can focus on the assumptions and technical bases in the license application that ensure dose estimates adequately consider these factors.

2.3. Evaluation of Alternative Models

CNWRA used alternative models [8,9] and field experiments [10] to test a USDOE hypothesis that strata in the unsaturated zone overlying the potential repository will cause water to flow laterally, thus shedding water from the repository footprint [11,12]. The alternate models and field investigations indicated that faults and fractures in nonwelded tuffs are likely to limit the lateral diversion of flow. One alternative model was calibrated using only field data, such as water table depth [13], while the other included qualitative information in the calibration. Comparisons with the USDOE contaminant plume provided a basis for comments on USDOE methods and assumptions and supported precicensing interactions with USDOE.

2.4. Evaluation of Adequacy of Analyses and Hearing Support

Independent scientific and engineering analyses support the regulator in evaluating the adequacy of analyses both before and during the hearing process. For example, to investigate ground response at surface facilities at the potential repository, CNWRA integrated available geologic and geotechnical data to construct a three-dimensional EarthVision[®] model of the surface facility area [14]. In this model, seismic properties of stratigraphic units were explicitly incorporated in contrast to the USDOE assumption of a single stratum with random distribution of properties. The CNWRA analysis showed that ground response varies significantly across the site and that stratigraphic effects at locations with thick subsurface layers of alluvium and nonwelded tuff can amplify ground motions by a factor of two.

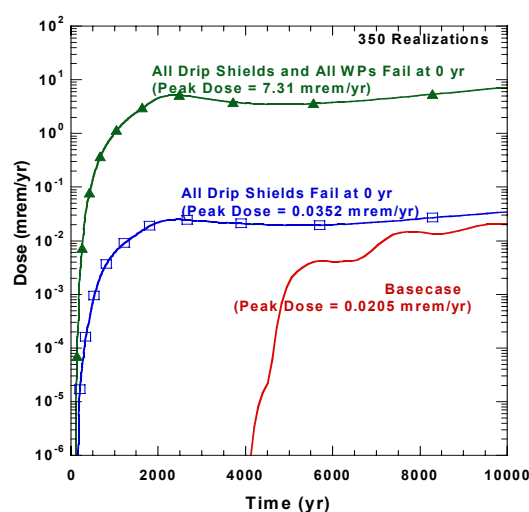


FIG. 3. A representation of system sensitivity to subsystem performance. The graphs indicate that drip shields have a relatively moderate influence while waste packages (WP) have a significant influence on system performance (1 mrem = 0.01 mSv).

2.5. Support to Public Outreach and Communications

Finally, independent analyses bolster public outreach and communication with stakeholders. Various techniques are used to increase the effectiveness of communications. Independent scientific and engineering analyses often underlie the physical models, computer visualizations, and animations that illustrate repository performance. More broadly, the fact that independent analyses have been conducted conveys to the stakeholders that CNWRA and USNRC are fully competent to challenge the assumptions and conclusions of the applicant and independently arrive at a conclusion about the safety of the potential repository.

3. Conclusion

With CNWRA attributes such as independence, competence, longevity, complementary skills, and clearly defined roles and responsibilities, USNRC is assured of being successfully supported by CNWRA. Since its inception in 1987, these attributes have been important to the success of CNWRA. Independent scientific and engineering analyses have proven to be particularly important, as illustrated in the examples presented.

REFERENCES

- [1] CODE OF FEDERAL REGULATIONS, “Disposal of High-Level Radioactive Wastes in a Geologic Waste Repository at Yucca Mountain, Nevada,” Title 10—Energy—U.S. Nuclear Regulatory Commission, Part 63, Washington, DC: U.S. Government Printing Office (2004).
- [2] USNRC, NUREG-1804, “Yucca Mountain Review Plan,” Rev. 2, Washington, DC: NRC (2002).
- [3] MOHANTY, S., et al., “System-Level Performance Assessment of The Proposed Repository at Yucca Mountain Using the TPA Version 4.1 Code,” CNWRA 2002-05, Rev. 2, San Antonio, Texas, CNWRA (2004).
- [4] CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM MANAGEMENT AND OPERATING CONTRACTOR (CRWMS M&O), “Yucca Mountain Site Description Document,” TDR-CRW-GS-000001, Rev. 01, ICN 01, Las Vegas, Nevada (2000).
- [5] CRWMS M&O, “Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations,” TDR-BWI-SBR-LB000001, Rev. 4, ICN 01, Las Vegas, Nevada (2000).
- [6] CRWMS M&O, “Near-Field Environment Process Model Report,” TDR-NBS-MD-000001, Rev. 00, Las Vegas, Nevada (2000).
- [7] USDOE, USDOE/EIS-0250D, “Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada,” Las Vegas, Nevada: USDOE, Office of Civilian Radioactive Waste Management (1999).
- [8] USNRC, “Issue Resolution Status Report, Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions,” Rev. 2, Washington, DC: USNRC (1999).
- [9] WINTERLE, J.R., “Evaluation of Alternative Concepts for Saturated Zone Flow: Effects of Recharge and Water Table Rise on Flow Paths and Travel Times at Yucca Mountain,” San Antonio, Texas, CNWRA (2003).
- [10] DINWIDDIE, C.L., et al., “Fault Zone Deformation Overprints Permeability of Nonwelded Ignimbrite: Chalk Cove Fault, Bishop Tuff, Bishop, California,” *Vadose Zone Journal*, Volume 5, 610-627 (2006).
- [11] CRWMS M&O, “Unsaturated Zone Flow and Transport Model Process Model Report,” TDR-NBS-HS-000002, Rev. 00, Las Vegas, Nevada (2000).
- [12] CRWMS M&O, “Simulation of Infiltration for Modern and Potential Future Climates,” ANL-NBS-GS-000032, Rev. 00, Las Vegas, Nevada (2000).
- [13] CRWMS M&O, “Saturated Zone Flow and Transport Process Model Report,” TDR-NBS-HS-000001, Rev. 00, ICN 02, Las Vegas, Nevada (2000).

- [14] GONZALEZ, S., et al., "Preliminary Evaluation and Analyses of the U.S. Department of Energy Geotechnical Data for the Waste Handling Building Site at the Potential Yucca Mountain Repository," San Antonio, Texas, CNWRA (2004).

New frontiers for the Nuclear Safety Analysis and TSO's challenges

Tewfik Hamidouche

Laboratoire des Analyses de Sûreté – Centre de Recherche Nucléaire d'Alger (CRNA),

02 Boulevard Frantz Fanon, B.P. 399, 16000 Alger, Algérie.

thamidouche@comena-dz.org

Abstract. Nuclear safety is one of the most important issues for the nuclear industry which considers that promoting high level of safety will ensure sustainability and induce economic performance. Enhancing safety passes through the development of validated tools, models and systems in order to demonstrate the safe operation of the plants during all stage of life. In the other hand, the licensing of any nuclear installation by the state regulatory bodies also passes through the assessment of the installation performance under several scenarios and hypothesis. This is a main purpose of TSOs attached to regulatory bodies. This task is generally made possible by the continuous development and assessment of tools and models and by an effective share of experience between all the partners in the nuclear industry. However, if this was made possible by the nuclear power industry because of the necessity to gain public acceptance and to higher the confidence in this technology, the situation is obviously not the same for the research reactor safety. The research reactors, as generally considered as small installations, which impact is not so considerable in case of accident compared to the impact of a nuclear power plant accident. However, in our opinion, even that the research reactors didn't experience any severe accident they are facing to ageing situations and for this reason, one of the new challenges to deal with by TSOs should concern the revisiting the safety of research reactors by upgrading the methodology adopted used to date and to follow the methodology used in the nuclear power industry and at the end attain a standardized methodology.

1. Introduction:

After the second war, nuclear power has emerged as a profitable source of energy for the development by providing safe, clean and sustainable energy to the world; however, the expected development in the utilization of this energy has been affected after the occurrence of Three Mile Island accident in 1978 and completely reduced after the Chernobyl accident in 1986. The nuclear industry has learned lessons from the above accident and has undergone major research and development in order to avoid these accidents to occur further and to reinforce the safety of existing installation by mitigating the effects of any accident. The safety was postponed priority 1 and one of the major fields focused on was the analysis of accidents.

To perform such an analysis, models and tools has been developed and experimental devices were settled up. The simulation tools were tested, assessed and compared to experimental data. The experiments mounted by different research institutions were shared in order to minimize the costs and to get common understanding of the phenomena under investigation. This has also helped to enhance safety capabilities by sharing knowledge between the specialists around the world using same techniques and in some cases standardized tools. Furthermore, these sophisticated tools are always under continuous enhancement and assessment. These activities were generally supported by international organization like NEA/OCDE, IAEA, WANO and also by the industry. The capitalized results of this industry effort are used as basis by national authorities to help making adequate decision in the licensing process. The successful of the cooperation and the experience shared by the nuclear partners were also made possible because of some standardization in the design of the NPP.

In the other hand, over the fifty past years, research reactors have progressed through a variety of tasks. These have included materials research using neutron scattering and diffraction, materials characterization by activation analysis and radiography, isotope production, irradiation testing, as well as training, and service as centres of excellence in science and technology. The research reactors has played important role in the understanding of the nuclear physics and in the development of the nuclear industry. Nowadays, they continue to play an important role in the generation of neutrons for different educational and social purposes.

As a consequence of the wide spectrum of utilization of the research reactors, there exist around the world large variety of designs, wide range of powers, different modes of operation and purposes of utilization, it was no possible to standardize any more the methodology like for the nuclear power industry.

An attempt to perform standardized safety analyses for RR was proposed by the IAEA in the framework of core conversion from the use of highly enriched uranium fuel to the use of low enriched uranium fuel. In this regard, the facility operator would be required to submit an amendment to, or a revision of, the Safety Report. For this purpose, a safety-related benchmark problem was specified in order to show and compare calculation methods used in various research centers and institutions over the world. This has shown that each participating institution has developed each own methodology and proper tools. Almost all of the safety analyses have been performed using conservative computational tools.

The challenge today is to revisit the safety features of the existing research reactors using Best Estimate codes and the coupled code technique. This will allow to verify that the safety requirements still met and when necessary to introduce some amendments coming from not only the new requirements but also in order to introduce new equipments from recent advancement of new technologies. However, as the existing plants have well established licensing procedures, including well founded analysis methods, the application of new innovative analysis methods have to be thoroughly evaluated, with specific emphasis to the capabilities of producing results that in general terms might be beneficial related to the RR operations.

2. Description of the tasks

The role assigned to our group is the development, validation and utilization of computer tools for the safety analysis of research reactors. To deal with these missions, the group has adopted a graded approach beginning from the selection of appropriate tools, their adaptation to specific operating conditions and their application for cases studies. In a second major step, the group has undertaken development activities and successfully developed computer tools for the determination of reactor intrinsic parameters and the analysis of accidents and transients such as reactivity insertion accident or RIA, loss of flow accident or LOFA and loss of coolant accident or LOCA.

Several assessment and validation activities have been performed but the group was always faced to the limitation access to validation matrix. Nevertheless, the models and tools have been applied to the benchmark exercise and the results were shown to be in the same range as of other institutions.

With the sustained development in computer technology, the possibilities of code capabilities have been enlarged substantially and consequently, advanced safety evaluations and design optimizations that were not possible few years ago can now be performed since very sophisticated methods and models that needed in the past heavy financial investment are nowadays accessible with minimal financial support when the technology is available.

Furthermore, due to the evolution of the computer technology, it becomes today possible to switch to new generation of computational tools using Coupled Code Technique. This method consists in coupling advanced codes each one in specific target areas of nuclear engineering in order to get more realistic simulations of complex phenomena and accidents in reactor cores. These new opportunities have opened new options for research in different institutions even those with limited resources and/or installations.

As a fact, for some countries such as ours, the challenge today consists of revisiting safety features of the existing research reactors in order to verify that the safety requirements are still met and when necessary to introduce some modifications coming from not only the new safety requirements but also by introducing new equipments as a result of recent advancement of new technologies. The results of these studies are the basic output expected by regulators from the technical and scientific support teams.

3. New Frontiers and challenges

The selection of a BE analysis instead of a conservative one depends upon a number of conditions. These include the degree of the current knowledge, the availability of computational tools, the availability of suitable nuclear research reactor data (the amount of data and the related details can be much different in the cases of best estimate or conservative analyses), or the requests from the national regulatory body.

Although the acceptability of the approach to be used for an accident analysis needs to be defined by the regulatory body, the use of totally conservative approaches (conservative models, input data and research reactor conditions) results unwarranted nowadays. Indeed, using a conservative approach in the analysis of specific scenarios provides some exaggerated results and hence the safety margins deducted are large enough to cover a great number of similar cases.

Furthermore, conservative analyses are still widely used to avoid the need of developing realistic models based on experimental data, or simply to avoid the tedious task in changing the approved code and/or the approaches or procedures to get the licensing. However, the results of such analyses did not give a true simulation of a specified scenario. In fact, no indications about the actual research reactor behavior or the real margins are provided.

By contrast, the phenomena, in the case of the BE methods, are simulated as realistic as possible according to the present knowledge and the obtained safety margins reflect more closely the real ones. Nowadays, the application of Best-Estimate (BE) methods constitutes a real necessity in order to get more realistic safety margins and consequently increasing the lifetime as well as the commercial productivity of these reactors.

The challenge today is to revisit the safety features of the existing research reactors using the coupled code technique. This will allow to verify that the safety requirements are still met and when necessary to introduce some amendments coming from not only the new requirements but also in order to introduce new equipments from recent advancement of new technologies.

In order to achieve the above commitments and to ensure high confidence of the results, TSOs have to undertake assessment and validation activities in order to demonstrate the applicability of these new techniques to the safety analysis of research reactors. This is the first requirement or step as recommended by the safety international community and organization such as IAEA, NEA and other regulatory bodies around the world.

The second one is related to the qualification of the safety analyst. The technical resources represent the heart of the technical support organization (TSO) and its role is to help make strong decisions in all

safety related questions of nuclear installation. However, the success in these missions is also dependent on the capabilities of an international cooperation and experience sharing between TSOs organizations acting in the same area or as a whole by regulatory bodies by participation to international forums and others. The IAEA have an important role to play as moderator actor between the partners.

The objective of this new approach is to assist in achieving and maintaining a high level of safety in research reactors application and utilization and to provide a training and qualification program for personnel as well as specialized guidance for regulatory bodies. The impact of such activity will contribute to resolve specific current safety issues and assist in making a standard methodology for the safety of research reactors like in the case of nuclear power plants.

Beyond of these technical challenges faced to by TSO, one other major question to solve is the renewal and the stability of qualified human resources; this is one of the most important challenges faced to by TSO worldwide and particularly in the majority of developing countries. Systematic training of analysts is crucial for the quality of the activities related to the TSO activities. In particular, international cooperation will help transfer competence and experience in performing safety analysis using new methodologies and approaches in order to achieve high safety operation level and to realize the global objective which the safe operation of any nuclear installation over the world.

REFERENCES: (major attainments in relation to the safety analysis of RR)

- [1] T. Hamidouche et A. Bousbia-Salah, "RELAP5/3.2 assessment against low pressure onset of flow instability in parallel heated channels", *Annals of Nuclear Energy* 33 (2006) 510-520
- [2] A. Bousbia-Salah, B. Meftah, T. Hamidouche and E.K. Si-Ahmed. "Model for the Analysis of loss of decay heat removal during loss of coolant in MTR pool type research reactors", *Annals of Nuclear Energy* 33 (2006) 405-414
- [3] A. Bousbia-Salah & T. Hamidouche "Analysis of the IAEA 10MW research reactor exercises by RETRAC-PC code", *Nuclear Engineering and Design* 235 (2005) 661-674
- [4] M. Adorni, A. Bousbia Salah, T. Hamidouche & F. D'Auria, "Application of Best Estimate Thermalhydraulic Codes for the Safety Analysis of Research Reactors", (paper S6-541) *Proceeding of the 6th International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Dubrovnik, Croatia, 21-25 May 2006*
- [5] A. Adorni, A. Bousbia-Salah, T. Hamidouche et al. "Analysis of partial and total flow blockage of a single fuel assembly in an MTR research reactor core", *Annals of Nuclear Energy* 32 (2005) 1679-1692
- [6] T. Hamidouche, A. Bousbia-Salah and E.K. Si-Ahmed. "Analysis of loss of coolant accident in MTR pool type research reactors". (Paper 073) *Proceeding of the International Conference of Nuclear Energy for New Europe 2005, Bled, (Slovenia), 5-8 September 2005*
- [7] T. Hamidouche, A. Bousbia-Salah, M. Adorni & F. D'Auria (ICONE-5036): "Comparative study of RELAP5/Mod3.2 code system and channel codes in the safety analysis of research reactors", *Proceeding of the 13th International Conference on nuclear engineering, May 16-20, 2005, Beijing (China)*
- [8] T. Hamidouche, A. Bousbia-Salah, E. K. Si-Ahmed & F. D'Auria (ICONE-5040): "Analysis of loss of coolant accident in MTR type research reactor", *Proceeding of the 13th International Conference on nuclear engineering, May 16-20, 2005, Beijing (China)*
- [9] T. Hamidouche, A. Bousbia-Salah, M. Adorni & F. D'Auria "Dynamic calculations for the IAEA Safety MTR research reactor Benchmark problem using RELAP5/3.2 Code", *Annals of Nuclear Energy* N° 31 (2004) 1385-1402
- [10] A. Bousbia-salah, T. Hamidouche & F. D'Auria : "Analysis of typical transients in the generic 10 MW IAEA MTR research reactor by RELAP5/3.2", *Proceeding of the International Meeting on*

Reduced Enrichment for Research and Test Reactors (RERTR), 7 – 12 November 2004, Vienna (Austria) (2004)

- [11] H. Mazrou, T. Hamidouche, K. Ibrahim and A. Bousbia-Salah. (paper N° 4D-04): "Computer code package COMPACK-LHW for M.T.R. research reactor core calculations", Proceeding of ANS Reactor Physics Topical Meeting, PHYSOR 2002, October 7-10, 2002, Seoul (Korea).
- [12] K. Ibrahim, H. Mazrou, T. Hamidouche, and H. Benkharfia. (paper N° 4E-22): "MUDICO-2D: A two-dimensional multigroup diffusion code for static studies and kinetic parameters calculations in light water research reactors", Proceeding of ANS Reactor Physics Topical Meeting, PHYSOR 2002, October 7-10, 2002, Seoul (Korea)
- [13] B. Baggourra, T. Hamidouche and A. Bousbia-Salah "RETRAC: A computer program for the Analysis of Materials Test Reactors", Nuclear Science and Engineering, Vol. 118, p 65, Sep 1994

Support for the inspection system improvement for the nuclear power plants

Masahide Kobayashi

Safety Information Research Division,
Japan Nuclear Energy Safety Organization (JNES)
3-17-1, Toranomon, Minato-ku, Tokyo Japan

Abstract. Review of the inspection system that a country enforced was going in Japan, but JNES kept the specialty and technical knowledge alive in fields such as foreign countries information, the field of maintenance management, human factor, performance evaluation of an licensees, quantity risk information, various private licensees standard development. The details of an inspection system and concrete examination are pushed forward in future, but JNES make use of specialty and am going to help NISA(Nuclear and Industrial Safety Agency).

1. A background of an inspection system review

NISA is performing a review of an inspection system for a nuclear power plant in Japan from November 2005. A point of this review is as follows.

- Develop to an inspection system corresponding to advancement of maintenance

In our country, time based maintenance was adapted conventionally, and the inspection system is optimised in time based maintenance, too. On this account the inspection will be carried out as a general rule every 13 months and become a limit of a operating cycle.

On the other hand, it becomes the mainstream to choose a maintenance method / a check period by reliability centred maintenance in the world and licensees take in the condition based maintenance that is in a state particularly positively and maintain safety and to carry out maintenance efficiently. By this, the degree of freedom of a operating cycle rises and carries out operating corresponding to demand more.

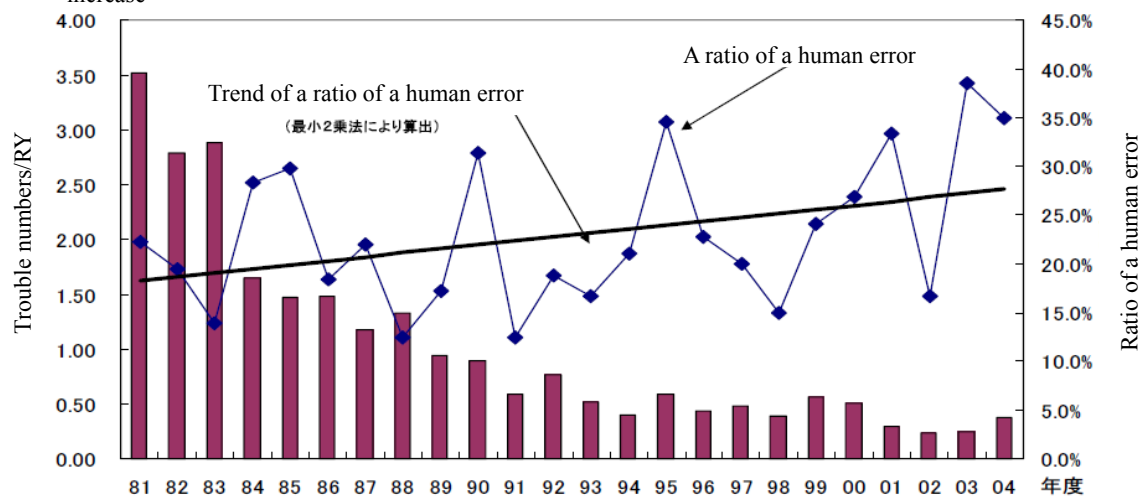
Through this review, it was requested the inspection system corresponding to advanced maintenance.

- Develop to an inspection system to lead to prevention of a trouble to occur in conjunction with human error

See figure of next page.

- A change of troubles and human error outbreaks that were reported to NISA -

From 1981 to 2002, the trouble number to occur per one plant and the human blunder number decrease throughout. On the other hand, the ratio that a human error holds among the trouble number is a tendency to increase



- Follow of non-enforcement item of a review result of 2002

Next seven items were nominated for a problem at the time of review of an inspection system of 2002. a) Substantiality of quality assurance activity, b) Introduction of non-announced inspection, c) Inflection of quantitative risk evaluation, d) Application of the inspection that accepted evaluation of a safety a performance, e) Maintenance of a standard / a standard, f) Mobile enforcement of a step based on a law, g) Inflection of a lesson and learn to be provided from a slight trouble

Of these, examination of a realization method was necessary about item c) and a d) clause of non-correspondence till now. In addition, the enforcement situation of an inspection system executed the work from October, 2003 and confirmation of the propriety were necessary.

2. Support contents

The range that this review intended for worked on maintenance and human factor, risk information practical use, performance evaluation of an licensees were wide and many sections of JNES participated and carried out support.

When the review examination of the inspection system that seems to be this time is carry out in our country, NISA establishes committees of a wide constitution member such as people of learning and experience, a representative (a local government) of a nuclear power plant geographical convenience area, a consumer, the mass media, and go ahead through examination to there in form NISA review it, and to decide plan in the last after having reflected public comment. It is this form this time and carries out JNES mainly on support through examination / making of a document to submit to the committee.

In addition, JNES carry out document making support for a review of a law revision, support of detailed examination for system realization, support in making of licensees standard / a standard corresponding to review contents. And, JNES will enforce a part of inspection to carry out if an

inspection system is decided to be concrete.

I show the support contents as follows every item.

2.1 Inspection system corresponding to advancement of maintenance

JNES investigated the enforcement situation of maintenance of an licensee of each country and an inspection system (regulatory systems) and offered information to NISA. The country, which JNES investigated, is U.S.A., France, and Finland. JNES carried out on desk investigation and visit investigation.

The visit investigation utilized an investigating group of the Japan Society of Mechanical Engineers mainly. The investigating group visited both of licensees and regulatory body with each country. In this Group, licensees, atomic energy plant maker and regulator were participated, so this investigating group can share maintenance activity of each country and knowledge about the situation of regulation, and I think that it was helpful review examination.

As a result of examination, each licensee makes the maintenance program which will be summarized maintenance activity in, and the regulation side will confirm this, and JNES proposed the original contents which should be included in a maintenance program, examination about a confirmation method. Maintenance contents corresponding to an aging deterioration phenomenon will be included in a maintenance program, and JNES proposed how should have included it.

In conjunction with a maintenance program, confirmation of the contents and the enforcement situation will be carried out in future, and JNES will be going to carry out developments of a database and a tool to perform inspection smoothly and effectively.

2.2 Inspection system to lead to prevention of a trouble to occur in conjunction with human error

As had spoken in the beginning throughout, the trouble number and the human error number to occur per one plant decrease in our country, but there is the ratio of human error among the trouble number in a tendency to increase. Therefore, NISA aimed at an inspection system to lead to prevention of a trouble to occur in conjunction with human error.

NISA decided prevention of a recurrence as follows. About an important phenomenon, the regulation authorities demand root cause analysis from an licensee, and in root cause analysis, licensee should analyze organization factors about the human factor side. It was carried out the study about organization factors and human factor in JNES, so in review examination of an inspection system, JNES carried out support by offering knowledge about the human factor, which accumulated.

In future, JNES will participate in making of a private standard about the root cause analysis that licensees carry out, and JNES establish a committee how you do evaluation / examination about the root cause analysis that an licensee carries out, and go ahead through examination, and JNES is going to propose it at NISA.

2.3 Follow of non-enforcement item of a review examination result of 2002

Follow items are "inflection of quantitative risk evaluation" and "an application of the inspection that accepted evaluation of a safety performance. Of the former, it can inflect in each field of this examination, so JNES carried out support of examination in every field. For a main thing, it is an importance classification of maintenance, the choice of the subject of inspection that accepted importance, importance evaluation of inspection findings, the choice of a performance index and calculation of a standard value.

About the latter, NISA decided to judge that performance will be evaluated from performance index and both of importance evaluation of an inspection findings. In conjunction with the choice of a performance index, JNES carried out making of the choice plan of an index, in addition, to really use that carried out inflection situation investigation of a performance index of each country. About importance evaluation of inspection findings, JNES examined an evaluation method of application of risk information, and an evaluation method of findings that is related quality assurance activity. In conjunction with general evaluation examination technique, JNES collect data of a plant, and make general evaluation sheet, and now JNES is carrying out test evaluation of all plants with NISA.

It is going to determine the last evaluation method through this test evaluation, JNES establish a committee led by people of learning and experience about evaluation and push forward examination, and we are going to propose it at NISA.

3. Conclusion

In review examination of the inspection that NISA carried out, JNES helped NISA by detailed investigation / examination than is related to accumulated technical knowledge or a specialized field till now. The field that JNES helped amounts to overseas information, a maintenance management field, a human factor, performance evaluation of an licensee, quantitative risk information, various private standards in depth.

A review of an inspection system of a country is in progress now, and will enter the details and concrete system examination in future, but JNES is going to help NISA in a various form / fields continuously.

Towards establishment of European clearinghouse on operational experience feedback

V. Rangelova^a , M. Bieth^a

^a Institute for Energy,
Joint Research Center,
European Commission,
Petten, The Netherlands

Abstract. Lessons learnt from the operational experience are extensively used to improve NPP safety worldwide. Recent initiatives have been taken by the US NRC to improve the effectiveness of this process through the establishment of Operational Experience Clearinghouse in the US NRC. At the conference on Improving Nuclear Safety through Operating Experience Feedback that was held in Germany 2006, the EU countries, operating nuclear reactors, discussed the possibility to establish a similar mechanism for EU region. As a spin-off of these discussions Mr. Laaksonen, Director-General of Finnish Radiation and Nuclear Safety Authority (STUK), approached in 2006 WENRA members as well as EC DG-TREN and DG-JRC to explore the possibility and encourage the establishment of an EU Clearinghouse for NPP Operational Experience Feedback with the support of JRC Institute for Energy (IE). In response to his request, the IE has prepared a vision on the way and practical means by which such a suggestion could be materialized. The main emphasis is given on the common EU activities which can help to optimize the use of national technical and scientific resources for operational event analyses, improve the communication means and ensure effective closure of the operational experience feedback loop by submitting event safety significant information to the right users at national regulatory authority level. This paper outlines the possible main activities, issues and concerns to be considered in the establishment of any mechanism to foster the effectiveness of operational experience feedback system in the EU countries.

1. Introduction

Several international forums, amongst which the Conference on Improving Nuclear Safety through Operating Experience Feedback that was held on the 29-31 of May 2006 in Cologne, Germany[1], have suggested that at Community level EU countries may benefit from pulling together their efforts to enhance the effectiveness of the operational experience feedback (OEF) process. Recognizing the importance of this safety issue, it was suggested by some EU Member States (MS) that EC JRC may play a central role in establishing and running of an EU Clearinghouse for Operational Experience Feedback for the benefit of all MS. It was felt important to use well established JRC working mechanisms and means, as well as available EU countries and JRC technical expertise in the field in order to promote better cooperation, more effective use of the limited national resources of the MSs and strengthening the EU capabilities for operational experience analyses and dissemination of the lessons learnt. This initiative was believed to further contribute to EU nuclear safety practices harmonization and add clear Community value to the relevant national efforts.

2. Main objectives of the new initiative

The proposed action provides an integrated approach to the research needed to strengthen the Community capabilities for assessment of operational experience of EU nuclear power plants and promote development of tools and mechanisms for improved application of the lessons learnt. This could be achieved through establishment and operation of European Clearinghouse for Operational Experience Feedback with the following main strategic goals:

- a) Improvement of EU NPP safety through strengthening co-operation between licensees, regulatory authorities and research and technical support organization staff to collect,

- communicate, and evaluate reactor operational events information and apply systematically and in a consistent manner lessons learnt throughout all EU countries.
- b) Establishment of European best-practice for assessment of NPP operational events, through the use of state-of-the art methods, computer aided assessment tools and information gathered from different national and international sources, such as EU Regulatory Authority event reporting systems, NRC Operational Experience Clearinghouse[2], Incident Reporting System (IRS) jointly operated by IAEA and OECD/ NEA[3], etc.
 - c) Provision of EU resource base of full time staff to analyse systematically EU OEF issues that is currently lacking from any international system between Regulatory Authorities in EU countries. To this end the establishment of international networking between experts who are involved in OEF, as well as direct links with each EU Regulatory Authority or its Technical Support Organization (TSO) will be pursued.
 - d) Support to the long-term EU policy needs on OEF, through exploitation of the JRC and European TSO competence in research in nuclear event evaluation methods and techniques.

The effectiveness of the operational experience feedback process in Europe could be improved through establishment of one central point for collection and systematic assessment of daily information on EU NPPs operational events and distribution of selected lessons learnt to the concerned national authorities.

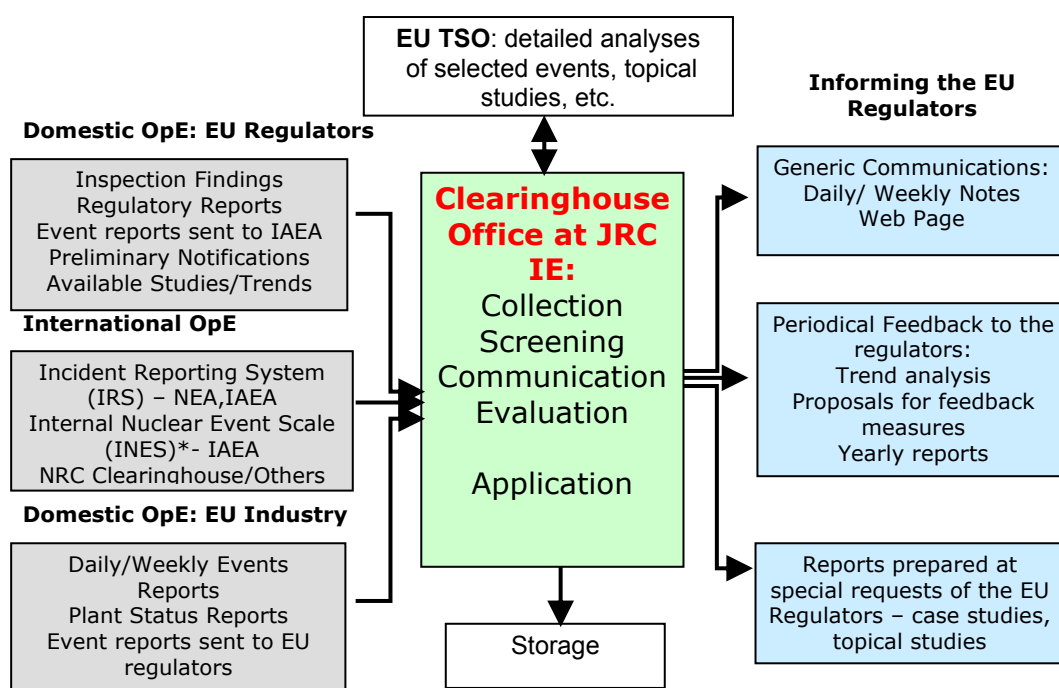
3. Main tasks and duties of the European clearinghouse on operational experience feedback

For successful implementation of the idea of European clearinghouse on operational experience feedback it is important that the mandate, tasks and duties of such a clearinghouse are well defined and specified in a way which demonstrates clearly the added value achieved at EU level. The tasks of the clearinghouse could involve, amongst other things:

- a) collection of operating experience directly from the European nuclear regulators or operators, assessing the potential value of lessons to other NPP's, and ensuring that events relevant for the global OEF are reported systematically and in consistent manner to the IRS system operated by NEA/IAEA,
- b) keeping timely contacts with the authors of the incoming reports as needed to improve the clarity and usefulness of the reported information,
- c) providing support to the original authors in categorizations of the European IRS reports (following the advice given in the IRS guidelines) to ensure consistent categorization and reduce the burden to the authors,
- d) distributing selected events to appropriate professional groups in Europe for detail event analyses (these groups could include the EU JRC networks, EU TSOs, appropriate research or industry institutions). The professional groups will be set up and used on a thematic basis. The assessment from such a group of an event may take several days or more depending on the complexity and significance of the particular event,
- e) evaluating the IRS reports received from outside EU and alerting the national regulatory bodies on most important events and significant corrective actions implemented. In addition to the IRS reports, collecting and analyzing other information received from international sources, where appropriate,

- f) establishing and maintaining a well organized and easily operated electronic OE database and website based platform for exchange of information, including powerful search functions; the database could be accessible also to users outside EU,
- g) providing summary reports of events with similar features or causes, conducting precursor studies of events at all European nuclear power plants, facilitating the trend analyses and enabling better understanding of the main patterns in operational experience events, and
- h) disseminating information on corrective actions taken at European facilities in response to lessons learned from experience in a timely and tailored to the needs of different users groups manner.

The flow of information and possible interactions amongst all concerned with the work of an European clearinghouse on operational experience feedback is presented schematically below:



* available to public

4. Involvement of EU TSO

To ensure successful implementation and functioning of a European clearinghouse on operational experience feedback it is of utmost importance to establish effective and powerful communication mechanisms for exchange of information amongst the Clearinghouse, the EU regulators, IAEA/NEA Incident Reporting System, US NRC Clearinghouse and different professional technical groups to assess events. Due to the limited national resources it is essential to mobilize the right expertise in Europe for analysis of each particular significant event from JRC networks, EU Regulators TSO, EU relevant research and industry organizations, etc. The role of EU regulators Technical Support Organizations such as IRSN, GRS, AVN, VTT, PSI, Rez NRI and others will be crucial and active cooperation has to be sought in the main field of their competence. For many of the technical areas the opinion or

assessment of several of these TSOs may be needed, too. Establishment of a well functioning co-operation which will maximize the benefit from involvement of different professional groups and will not result in excessive burdens to any of these organizations will be one of the main challenges to be met in future.

5. Conclusions

There are clear potentials for enhancement of the European process used for the NPP operational experience feedback. The experience of US NRC shows that the establishment of centralized OpE clearinghouse for a particular region in the world can yield significant benefits both in terms of optimized use of resources and improved feedback of significant lessons learnt at NPPs. The USA experience can help to foster establishment of the working mechanisms needed for the EU Clearinghouse, however due to specificity of the different regulatory regimes, significant diversity of the NPP designs in EU and number of different languages used, the task for establishment of the EU centralized clearinghouse will be more complicated and challenging and will need strong support and high management commitment from the EU regulators. Furthermore it will be important also to evaluate and analyse the operational experience feedback practices in all EU NPP operating countries to identify the best practices and build on them when establishing a common mechanism on OEF to work in the context of the EU.

REFERENCES

- [1] Improving Nuclear Safety through Operating Experience Feedback (Proc. Conf. Cologne, 2006), GRS, Cologne (2006)
- [2] UNITED STATES NUCLEAR REGULATORY COMMISSION, Event Assessment (200), <http://www.nrc.gov/what-we-do/regulatory/event-assess.html>
- [3] ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, NUCLEAR ENERGY AGENCY, Nuclear Power Plant Operating Experiences from IAEA/NEA Incident Reporting System 2002-2205, ISBN 92-64-02294-5, OECD, Paris (2006)

LANL's Offsite Source Recovery Project as a Tool to Handle Unwanted/ Disused Radioactive Sources

Galya I. Balatsky, William R. Severe

Los Alamos National Laboratory

Los Alamos, NM, USA

Abstract. Offsite Source Recovery Project (OSRP) at the US Los Alamos National Laboratory is a good example how a laboratory can assist in improving nuclear and radiation safety in the US and other countries. OSRP also supports the US Global Threat Reduction Initiative in the area of removal and recover of radiological materials. In particular, OSRP locates, identifies, and removes disused and unwanted sources from various locations in the US and internationally.

1. Introduction

In the United States, the Los Alamos National Laboratory (LANL) has unique experience in providing expertise and human resources, both in the US and internationally. By virtue of the OSRP program, the flexibility of US regulators and practitioners has been increased by new venues established by OSRP to deal with unwanted or unneeded sources. This includes assisting small companies and educational institutions that do not have the assets, knowledge or funding to comply with complicated and expensive regulations. OSRP also provides independent experts who have contributed their considerable technical and scientific expertise to solve difficult situations. In addition, OSRP has helped increase public confidence in everything nuclear by their professional management of several high profile source recoveries. In its approach, OSRP follows guidelines developed by IAEA on safety and security of radioactive sources [1].

2. Description of Offsite Source Recovery Project: development of capabilities and the current state

As of autumn 2006, OSRP removed about 14,000 radioactive sources from at risk locations: about 600 points in the U.S., Puerto Rico and several other countries (see Table 1). The project has developed over time; initially under the project only greater than Class C (GTCC) sealed sources were considered. After the September 11 2001, the scope of the project changed and began reflecting not only environmental concerns but concerns over public safety and national security, resulting in mission expansion. The new mission includes recover of beta/gamma emitting sources, representing concern to the US government and IAEA.

Table 1. Sources recovered in the U.S. and foreign countries by OSRP.

Location	Quantity	Additional detail
United States	13,497	
Puerto Rico	2	The sources were returned to the US for disposal.
Uruguay	3	
Africa	68	The US-origin sources were taken out from South Africa, Sudan and Ivory Coast
Singapore	1	The source is prepared for disposal in Germany
Australia	110	The US-origin sources were recovered

Currently, the OSRP mission covers sealed sources containing the following nuclides: ^{238}Pu , ^{239}Pu , ^{241}Am , ^{252}Cf , ^{244}Cm , ^{90}Sr , ^{137}Cs , ^{60}Co , ^{192}Ir and ^{226}Ra (see Fig 1).



FIG 1. Examples of the ^{241}Am well-logging sources recovered by OSRP in the U.S.

3. Support of the US Global Threat Reduction Initiative

Since the introduction of the Global Threat Reduction Initiative (GTRI) in 2004, radiological source recovery and removal efforts have become key elements of GTRI's efforts to reduce the security threat to the international community posed by these sources. GTRI has identified three basic options for reducing the threat of radioactive sealed sources.

Convert: Find alternative technologies that replace dependence on radioactive sealed sources.

Protect: Where sealed sources remain in-use, assure a strict degree of control through effective regulation which equally stresses safety and security.

Remove: Where radioactive sources are excess, unwanted or at risk because of inadequate control, the threat reduction alternative is to recover and remove the material to secure storage or disposal.

OSRP provides support to GTRI with the recovery and removal of radioactive sources [2]. These activities are conducted in cooperation with the IAEA Department of Nuclear Energy, Waste Technology Section, and the Department of Nuclear Security and Safeguards. The following support activities have, with GTRI support, been provided to IAEA.

- **Spent High Activity Radioactive Source (SHARS) Development and Deployment.** Supported the design, fabrication, testing, training and deployment of SHARS conditioning facility.
- **International Catalogue of Sealed Radioactive Sources and Devices.** Supported the development and provided a cost free expert for the implementation of the data base.
- **Infrastructure Support.** Supported the IAEA in the use of field recovery capabilities, including training and development of recovery teams for international source recoveries.
- **Support of Field Activities.** Participated in IAEA source recovery operation in Uruguay, South Africa, and Singapore.

In the coming months a number of source recoveries are planned from Europe, Australia, Africa and Latin America. Some of these will be direct repatriations of U.S. origin sources. Others will

be more comprehensive and include training and support to IAEA recovery and removal initiatives.

4. Looking in the future: long-term challenges for nuclear and radiation safety

Finally, let's discuss long term issues and challenges associated with the safe and secure use of radioactive sources and the need to develop effective end-of-life strategies for all disused, unwanted radioactive sources [3].

Based on OSRP experience, the challenges can be summarize as follows.

- Insufficiently developed national infrastructures and legal frameworks for controlling the import, export, and use of radioactive sources according to international norms and standards;
- Not well established inventory and control mechanisms for radiological sealed sources;
- Presence of high-risk, vulnerable radiological materials around the world that should be identified and removed in secure and safe locations;
- Insufficient availability of transportation options, including deficit of internationally approved containers and shipping companies qualified to transport radioactive materials.
- Gaps in sources' lifecycles that often do not include a reasonable end-of-life solution;
- Reluctance on part of countries-of-origin to repatriate radiological materials, as suggested in IAEA INFCIRC/663 Section 27

REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, INFCIRC/663, IAEA, Vienna (2005)
- [2] LEONARD, LEROY E., The Global Threat Reduction Initiative – Radiological Materials, Recovery and Removal, INMM 2006 Meeting, Nashville, TN, (2006).
- [3] BALATSKY, GALYA I., SEVERE, WILLIAM R., Balancing Progress and Responsibility, 2006 ANC Winter Meeting and Nuclear Technology Expo "Ensuring the Future in Times of Change" (in preparation).

TOPIC: Role of TSOs in enhancing nuclear and radiation safety: Support to the regulatory/licensing process in developing and establishing regulations.

Radionuclide Migration at Sites of Temporary Storage of SNF and RW in North-West Russia – Contribution to Regulatory Development

M.K. Sneve^a, N.K. Shandala^b, G.M. Smith^c, E.I. Orlova^b, I.M. Barraclough^c, A.V. Titov^b, O.A. Kochetkov^b

^a Norwegian Radiation Protection Authority, Oslo, Norway

^b State Research Centre – Institute of Biophysics, Moscow, Russian Federation

^c Enviro Consulting Ltd, United Kingdom

E-mail address of main author: Malgorzata.k.sneve@nrpa.no

Abstract. Two technical bases of the Northern Fleet were created in the Russian northwest in the 1960s at Andreeva in the Kola Bay and Gremikha village on the coast of the Barents Sea. They maintained nuclear submarines, performing receipt and storage of radioactive waste and spent nuclear fuel. No further stored material was received after 1985. These technical bases have since been re-categorised as sites of temporary storage. It is necessary to note that, during the storage of RW and SNF, certain conditions arose which resulted in failure of the storage barrier system, resulting in release of radionuclides. Remediation activities at the site focus on reduction of major risks associated with most hazardous radioactive source terms. In addition, the long term management of the sites includes consideration of how to remediate contaminated areas, not only because they affect continuing work at the site, but also because this work will influence final radiological status of the sites. The optimum approach to remediation will be affected by how quickly radionuclides could move, both during the remediation works and, so far as any residual activity is concerned, after the works are completed. Present investigations reported here are directed to determination of sorption-desorption parameters of radionuclides in the studied areas, which will affect their underground migration, with the purpose of accounting for regional peculiarities in optimization process of the STSs remediation. The work is being carried out by the TSO State Research Centre – Institute of Biophysics, of Russian Federation, with assistance from western experts. The work forms part of a regulatory collaboration programme on-going between the Norwegian Radiation Protection Authority and the Federal Medical-Biological Agency which is designed to support the development of norms and standards to be applied in the remediation of these sites of temporary storage.

1. Introduction

Two technical bases of the Northern Fleet were created in the Russian northwest in the 1960s at Andreeva in the Kola Bay and Gremikha village on the coast of the Barents Sea. They maintained nuclear submarines, performing receipt and storage of radioactive waste (RW) and spent nuclear fuel (SNF). No further waste was received after 1985. These technical bases have since been re-categorised as sites of temporary storage (STS).

According to an order of the Government of the Russian Federation in 2001, control of the STSs was transferred to Minatom of Russia with the purpose of over-seeing their remediation, with the work being carried out by the Federal state unitary enterprise «SevRAO».

The STS in Andreeva Bay is the biggest site for SNF and RW storage; there are about 1.3×10^{16} Bq SNF in the storage areas with decay cooling of more than 25 years, and about 6.6×10^{14} Bq RW. The main radionuclides are fission products ^{137}Cs and ^{90}Sr . At Gremikha STS total activities of SNF and RW are, respectively, 100 and 20 times less than at Andreeva Bay STS. Current conditions of SNF and RW storage at STS caused substantial degradation of some part of SNF during its storage.

Moreover, considerable amount of radionuclides has already penetrated into the soil near the storage areas at the depth of few meters. Potential of this contamination spreading as well as those of other possible contaminations generates additional risks both of local and regional scale. Further description of the radiological situation of the sites is given in [1].

The studies are directed to determination of sorption – desorption parameters of radionuclides in examined units that would affect underground migration. During underground migration, radionuclides are carried from the contamination sources, along with infiltrating rainwater, to subsoil water and further to the points of discharge to the sea. The transfer of radionuclides into subsoil water is primarily defined by their entry path from contaminated soils, while the transfer of radionuclides from subsoil water into the sea depend on their sorption by rocks of the upper water-bearing horizon.

2. Material and investigation methods

Experiments relating to desorption and sorption were performed in static conditions. The experimental method included periodic, short-time (2-3 min) mixing of examined sample with water over the course of a working day, and further suspension lift-off over 20 hours. The soil samples used in the desorption experiments were those which had being collected on-site at the STSs [1]. The larger part of soil was dried in air, weighed and then covered with pure natural water with very low mineralization. The ratio between solid and liquid phases was selected, within the range of 1.3 – 3.0, depending on moisture capacity of soil sample. After contact, water was separated from the soil sample and radionuclide filtrate content was determined. New portion of pure water was added to the rest of the soil and the experiment was repeated 2 or 3 times, depending on the initial sample contamination.

For the prediction of radionuclide underground migration data are required of distribution factors (K_d) of nuclides between soils and filtering contaminated waters. This factor is equal to the ratio of activity concentration of each of radionuclide in filtrate to equilibrium activity concentration in soil. K_d determination was implemented in static conditions. The strategy consisted of mixing of sand sample of natural mechanical content with some quota of contaminated water containing one of radionuclides, almost until equilibrium establishment. Hydrocarbonate natural water of 240 mg/l mineralization and calcium–sodium cation content was used. The ratio between solid and liquid phases was 1:2. The duration of mixing was 1-2 hours and the mixture then settled during approximately 20 hours. Decantate was separated from sand, then it was filtrated and its activity concentration was determined, while new portion of water was added to the sample and the experiment was repeated 3-5 times depending on sorption ability of sand. Three experiments were performed concurrently for each of the samples. Subsequent additions of initial solution to the sample of soil allowed, within certain degree, approximation of data obtained in static conditions to results observed in the process dynamics. The distribution factor was calculated for each of the solution additions to each sample (K_{di}):-

$$k_{di} = \frac{S_{i-1} + (C_0 - C_i) \cdot V}{C_{im}} \quad (1)$$

where: C_0 – activity concentration of initial solution, Bq/cm³; C_i - activity concentration of equilibrium solution, i – addition, Bq/cm³; m – mass of sand sample, g; V – volume of initial solution, cm³; S_{i-1} – amount of sorbed radionuclide with sand sample in previous additions, Bq.

Then K_d was determined as the mean value by all of the additions from three concurrent experiments with standard deviation at 0,95 confidence probability..

3. Result and discussion

The radiation situation at STS off-industrial sites territory is defined by: a) value of activity, b) mobility or immobility of contamination and 3) mechanisms and pathways for migration [2]. Migration pathways are affected by man, as well as the physical and chemical state of radioactive contamination and migration media, especially in water systems. The results of desorption studies are given in table 1 for ^{137}Cs and ^{90}Sr .

Table 1 – Radionuclide desorption from soil by water

№ soil sample*	Content of soil	№ water addition	^{137}Cs		^{90}Sr	
			Desorption, %	$K_{ds}, \text{g/cm}^3$	Desorption, %	$K_{ds}, \text{g/cm}^3$
1	Humus lightly sanded	1	0.015	1.8×10^{-3}	1.4	1.8×10^{-2}
		2	0.09	1.2×10^{-3}	0.9	1.1×10^{-2}
2	Humus with additions of sand and weathered stone	1	0.21	6.3×10^{-3}	2.0	6.0×10^{-2}
		2	0.06	2.4×10^{-3}	0.9	3.0×10^{-2}
3	Peat with weathered stone	1	0.40	5.5×10^{-3}	3.2	4.8×10^{-2}
		2	0.20	2.8×10^{-3}	1.2	1.8×10^{-2}
4	Humus with small of main rock	1	0.10	1.1×10^{-3}		

Here, ^{90}Sr mobility, as determined by K_{ds} , is approximately 10 times greater than that of ^{137}Cs . Following desorption, physical-chemical states of radionuclides in filtrates were defined using ionites: KU-2-8 cationite in sodium-form and AV-17 anionite in chlorine form. Almost full absorption of ^{137}Cs and ^{90}Sr cationite shows that they are in a form of cations in infiltrate waters, and their spreading with subsoil waters depends on sorption processes. Radionuclides being desorbed by precipitation, during infiltration, enter to the upper water-bearing horizon where they are sorbed by water-containing rocks. According to [2], at the industrial sites of STS in Andreeva Bay, the nearest to the surface horizon is located at a depth of 1 – 2.8 m, its power (i.e. depth of water-bearing horizon) is 0.2 – 1.7 m. There are nonartesian waters, their contents is hydrocarbonate calcium-sodium. The horizon water supply is due to rainwater infiltration; into lower second water-bearing horizon. Clay soils of sea nature serve as the lower aquiclude. Sands are the main water-containing rocks, whose data on granulometric content is practically absent. The limited results obtained show tendencies expected from results elsewhere.

Data for concentration profiles are available from the STSs. In cores of holes №3 and №12, slow decreasing is observed of the concentration ratio $^{137}\text{Cs}/^{90}\text{Sr}$ with depth; this serves as an evidence of high ^{90}Sr mobility in comparison with that of ^{137}Cs . The contents of radionuclides in the surface layer together with processes of sorption - desorption define the specific activity of radionuclides in core samples. Some sharp decreasing of ^{137}Cs concentration (about 25 times) with core depth (0-0.5 m) in hole 2, is perhaps, due to its very low washing-out from the surface layer and to its considerable sorption by bedding ground up to 0.5 m depth. These grounds absorb ^{90}Sr slightly. So, the ratio of specificity activities for $^{137}\text{Cs}/^{90}\text{Sr}$ in the present core at depth of 0.5 m is practically the same as that of the rest samples (0.5 m) from holes 3 and 12.

Thus, when considering pathways of radionuclide migration from the surface of the industrial site territory, ^{90}Sr has to dominate in underground waters. Really, the ratio of specific activities $^{137}\text{Cs}/^{90}\text{Sr}$ in underground water from two examined holes was about 0.006. At the same time, in averaged seawater sample collected in point 12, this ratio $^{137}\text{Cs}/^{90}\text{Sr}$ equals ~ 1 . Presented data on ratios of $^{137}\text{Cs}/^{90}\text{Sr}$ in seawater confirm that contaminated territory of STS industrial site serve as a source of radionuclide intakes into coastal area of the Barents Sea. Seawater contamination may be implemented by means of two pathways a) with underground water and b) due to washing away from the soil surface. As activity ratio of Cs and Sr in seawater is similar to that measured in underground water, it could be assumed that seawater contamination is due to releases from the site.

4. Conclusion

The distribution of radionuclides in the environment within and outside the STSs depends on man-made and natural conditions as well as the physical and chemical characteristics of the radioactive contamination. Measurements have been made to understand these features at the STSs including locally relevant sorption and desorption.

Based on the current work, the following conclusions are made:

- The sorption – desorption parameters of ^{137}Cs and ^{90}Sr , specifying the process of radionuclide interactions with soils and weathered rocks in infiltration of precipitation and in underground flux, respectively have been determined. It was shown that ^{90}Sr desorption is approximately an order of magnitude greater than ^{137}Cs washing-out, while ^{90}Sr sorption by the weathered rock is on average 26 times lower than their ^{137}Cs absorption value. Conditions help to increase underground migration of ^{90}Sr and its entrance into sea water of the coastal area of Motovsky bay of Andreeva and Chervyanaya Bays near Ostrovnoy and Gremikha village.
- Currently, the ratio concentrations of $^{137}\text{Cs}/^{90}\text{Sr}$ in the ground cores decreases gradually from 2.7 – 2.8 at the surface to 1.2 – 1.8 and 0.2 – 0.3 at a depth of 0.5 and 1 m, respectively. The ratio of concentrations $^{137}\text{Cs}/^{90}\text{Sr}$ in the ground water of the first water bearing horizon varied in the range of $<(0.15 - 0.2)$, while in the ground water of the second water bearing horizon was ~ 0.006 according to data from 2004 - 2005.
- A lot of materials specifying flows of radionuclide underground migration are required to develop criteria and guidance for remediation of radioactive contaminated territories taking into account their impact to the radiation state of sea media. Hence, the investigation are to be continued of processes of ^{137}Cs and ^{90}Sr interaction with soils, grounds and bottom sediments; at the same time, content of ^{137}Cs and ^{90}Sr and ^3H should be determined in these units, as well as in underground and sea water.
- There is an opportunity to evaluate radionuclide migration abilities in natural conditions, using data on contents of ^{137}Cs and ^{90}Sr in cores, currently being extracted during building of new observation holes at the industrial site at Andreeva Bay.
- Information on the scope for radionuclide migration from the site will be used to support regulatory decisions on the suitability of proposed remediation options and deveopment of remediation criteria.

ACKNOWLEDGEMENTS

The work described in this paper is funded by the Norwegian Government, through a Plan of Action implemented by the Ministry of Foreign Affairs (MoFA) promoting improvements in radiation protection and nuclear safety in North-West Russia.

REFERENCES

[1] Ilin L, Kochetkov O, Shandala N, Savkin M, Sneve MK, Børretzen P, Jaworska A, Smith G, Barracklough I, Kruse P. Initial threat assessment: Radiological risks associated with SevRAO facilities falling within the regulatory supervision responsibilities of FMBA. StrålevernRapport

2005:17. Østerås: Statens strålevern (Norwegian Radiation Protection Authority), 2005.
http://www.nrpa.no/dokumentarkiv/StralevernRapport17_2005.pdf (28.03.06)

[2] Radiation-spectrometric examination of buildings < constructions? Samples of soil and rock ground, being obtained in boring at Andreeva bay /Report №16.1253. – Moscow: FSUE NIKIET – 2004. – 85 p.

Probabilistic Safety Analysis of Nuclear Fuel Cycle Facilities in the Russian Federation

T.Y. Bogdanova, B.G. Gordon, S.V. Tsvetkov, R.B. Sharafoutdinov

Scientific and Engineering Centre for Nuclear and Radiation Safety,
Federal Environmental, Industrial and Nuclear Supervision Service of Russia,
Moscow, Russian Federation

Abstract. As it was shown by the practice of probabilistic safety analysis (PSA) of nuclear power plants, the results of probabilistic assessment may be a good addition to the results of deterministic safety assessment of nuclear fuel cycle facilities (NFCF). The paper reviews the issues-of-the-day of the probabilistic safety assessment of nuclear fuel cycle facilities, possibilities to use the results of PSA of nuclear fuel cycle facilities in safety regulation.

1. Introduction

In the RF a complete nuclear fuel cycle is implemented: uranic ore extraction, nuclear fuel production, reprocessing of irradiated fuel of nuclear reactors and isolation of fissible materials and radionuclides suitable for further use, treatment and disposal of radioactive waste.

Activity of the NFCF in the RF, as any activity in the area of nuclear energy use, is to be licensed by the State Regulatory Authority (Rostekhnadzor) [1-4]. In order to obtain a license, organizations that operate NFCF, submit to Rostekhnadzor a set of documents, which includes a Safety Justification Report (SJR), a plan for decrease of radioactive releases and effluents and other documents depending on the type of licensed activity [5]. SJR is to include the results of the NFCF deterministic and probabilistic safety analyses [6].

2. Current Approaches to the NFCF Safety Assessment

The basis of the NFCF safety assessment is traditionally presented by the deterministic safety analysis. In accordance with international practice a deterministic approach is used in the design accident analysis as reliable demonstration of admissibility of the design accident consequences, effectiveness of safety systems and also for determination of the NFCF safety operation limits. Deterministic nuclear and radiation safety analysis assumes studying of the types of potential accidents, radioactive substances releases and other accident consequences – taking into consideration neither the probability of such event occurrence, nor the probability of different variants of consequences.

PSA allows to detect vulnerabilities from the safety point of view (systems, technological processes), which may be not revealed in the frames of deterministic approach. In particular, only with the help of PSA it is possible to obtain quantitative information on probability and consequences of potential accidents at the NFCF, on significance of events and components during occurrence and development of the accidents and also on the most optimal methods of decrease of the risk of accidents.

In recent years, because of intensive development of directions of probabilistic risk assessment in chemical industry [7-9] and due to the accumulated wide experience in NPP PSA in the RF, more and more representatives of regulatory authorities and scientists declare for the use of information on the risk of accidents for the NFCF safety regulation [10-13]. Though receipt of this information is unconditionally accompanied by a number of difficulties, it may become a valuable addition and even a basis for making regulatory decisions.

3. Use of PSA Experience in Safety Assessment of the NFCF

All probabilistic safety analyses of the NFCF that have been accomplished by to-day in the RF, were initiated either by the branch research institutes or by the operating organizations. Not the least aim of these works was to understand the real perspectives and practical necessity of conducting PSA for the NFCF. A number of researchers carried out only assessment of the probable accident frequency, while the accident consequences were not assessed; basing on results of the assessment, the experts made decisions on adequacy or inadequacy of measures for safety support. In cases, when accident consequences were also assessed, experts formulated recommendations for decrease of risk of accidents at the NFCF, aimed at decrease of the accident probability and mitigation of their consequences [20].

a. *Probabilistic Calculations*

Practice has shown that determination of probabilities of accidents at Russian NCF is connected with various difficulties. Frequently initial data for carrying out of proper numerical calculations are not presented or collection of data is difficult because of a number of internal peculiarities of the facility and of the branch in general. It is one of the reasons why the probabilistic constituent of the NCF safety assessment is insufficiently taken into consideration by the operating organizations. To say the truth, it is necessary to note, that the problem of initial data is also actual in other advanced countries, where it is solved by operating organizations by creation of special data bases on reliability of equipment or by the use of analogous data of adjacent industry branches (operation of nuclear power plants and chemical facilities) [14-18]. It is possible, that the problem of initial data in the RF is to be solved by analogical methods.

b. *Criteria of Risk-Informed Decision Making*

Some countries – members of the IAEA have criteria and practice of decision-making basing on probable accident frequency and its consequences, expressed as the dose units for persons exposed in result of the accidents [14].

This approach is also met in the RF. In particular, in the paper [12] it is proposed to use a criterion of acceptable radiation risk from all potential accidents. In the paper [19] risk matrix was proposed, based on numerical assessment of the accident frequencies and on qualitative assessment of these accidents consequences. Depending on their combination it is supposed to establish the deadlines for taking corrective measures.

Nowadays no criteria have been established for decision-making on the basis of information on the risk of accidents at the NCF in the RF. Only a certain reference point has been set, a special index for frequency of beyond design accidents, when evacuation of the population may be required – it must not exceed 10^{-6} cases per year [6]. Accordingly, in case of exceeding, technical decisions shall be provided at the NCF for the accidents management with the purpose of their consequences mitigation. Generally speaking, the problem of taking into consideration the accident consequences in criteria of decision-making is rather difficult for the NCF because of their significant variety and specificity.

4. Possibilities of the PSA Use

Besides «evident» application of the PSA – assessment of accident risks at the NCF and following management of these risks, application of PSA results in SJR of the NCF,

SEC NRS also studies the perspectives of analysis of violations of the NCF operation by PSA methods. Fortunately, for the recent years Russian NCF have not met with serious violations (all violations were given «0» category by INES). Meanwhile, analysis of operational violations at nuclear power plants conducted by the specialists of SEC NRS with the probabilistic analysis methods, showed, that violations of the 0 level by INES may significantly influence on the change of the safety level of nuclear power plants – to increase the frequency of core damage. It is not excluded, that events, which occur during some operational violations at the NCF, under concatenation of circumstances may increase probability of accidents, and hence, influence on safety level of the NCF.

Results of such additional probabilistic analysis of violations may be used in the assessment of the current NCF safety level. Such assessment is carried out annually by the specialists of SEC NRS on the basis of annual reports on nuclear and radiation safety, reports on investigation of violations and other information with the purpose of scientific and engineering support of regulatory activity of Rostekhnadzor.

5. Conclusion

Present-day risk theory comes from the fact that no man-created facility can be absolutely reliable. Nevertheless, knowing calculated probability of accident at the facility and foreseeing its consequences, it is possible to judge the facility safety. Really, if the accident probability and foreseen damage are small, i.e. the value of the accident risk is low, it will be logical to declare that a facility is safe [9]. However, for making any risk-informed decisions, criteria of decision-making are to be determined, corresponding regulatory base is to be developed and the ways of solution of the above-mentioned actual problems are to be found, including deficiency of initial data, deficiency of understanding of significance of probabilistic constituent of the NCF safety and others.

REFERENCES

1. «Provision of Licensing Activity in the Use of Nuclear Energy» approved by Decree of the Government of the Russian Federation of June 14, No. 865 (1997).
2. Federal Law No.170-FL «On the Use of Nuclear Energy» of November 21 (1995).
3. Federal Law No.3-FL «On Radiation Safety of Population» of December 05 (1995).
4. Federal Law No.158-FL «On Licensing of Special Types of Activity» of September 25 (1998).
5. RD-015-02 «Requirements to the Set and Content of Documents, Justifying Nuclear and Radiation Safety of Licensed Types of Activity and Facilities of Nuclear Fuel Cycle and Licensed Types of Activity and Facilities of Organizations, Carrying Out the Works and Rendering Services to the Nuclear Fuel Cycle Facilities» (2002).
6. RR-016-05 «General Provisions of Ensuring Safety of Nuclear Fuel Cycle Facilities» (2005).
7. Gorsky V.G., Kurochkin V.K., Dumaev K.M., Novoseltsev V.N., Braun D. L. Risk Analysis – Methodological Basis of Ensuring Safety of Chemical and Technological Facilities. Russian Chemical Journal. (1994) №2. – p. 54-61.
8. Egorov A.F., Savitskaya T.V. Safety Management of Chemical Production on the Basis of Informational Technologies. M.: Chemistry, KolosS (2004).
9. Kolodkin V.M., Murin A.V., Petrov A.K., Gorsky V.G. Quantitative Evaluation of the Risk of Chemical Accidents. Izhevsk: Publishing House «Udmurtsky University» (2001).
10. Technical Note on Workshop on PSA for Non-Reactor Facilities. OECD/NEA Workshop on PSA for Non-Reactor Nuclear Facilities (2004).
11. Gordon B.G. Ideology of Safety. Proceedings of SEC NRS, Moscow (2005).
12. Petrin S.V., Zagorodnev V.A., Kovachenko O.V., Petrina L.S., Pinaev V.S. Safety Analysis of Facilities and Technologies. Methodological Manual on the Problems of Risk Regulation. Sarov: FGUP RFYATS-VNIIEF (2003).
13. Novikov G.A., «On the Problem of Realization of the Federal Law «On Technical Regulation»». «Nuclear and Radiation Safety» p. 3-11, №3, (2006).
14. IAEA-TECDOC-1436 «Risk-Informed Regulation of Nuclear Facilities: Overview of Current Status», IAEA, Vienna (2005).
15. H. Tsuboi, NISA's Approach to Apply Risk Information to Safety Regulation for Fuel Cycle Facilities, OECD/NEA Workshop on PSA for Non-Reactor Nuclear Facilities (2004).
16. K. Yoshida, H. Tamaki, T. Kimoto, N. Watanabe, K. Muramatsu, Methodology Development and Application of PSA for MOX Fuel Fabrication Facilities, OECD/NEA Workshop on PSA for Non-Reactor Nuclear Facilities (2004).
17. U. Yoshinori, T.Mitsuhiro. Outline of and a Topic about Risk Assessment Study for Fuel Cycle Facilities at JNES. OECD/NEA Workshop on PSA for Non-Reactor Nuclear Facilities (2004).
18. A. Buchan. Equipment Reliability Data Collection at the Sellafield Site. OECD/NEA Workshop on PSA for Non-Reactor Nuclear Facilities (2004).
19. Bakin R.I., Frolova O.B., Shikin A.V., Kizin V.D., Usoltsev V.Y., Shkokov E.I., Bruce A. Russell, Thomas I. McSweeney. Ranging of Priorities in Decrease of Risks at Concrete Nuclear Fuel Cycle Facilities on the Example of NIIAR. 2-nd International Workshop «Problems of Risk Decrease in the Use of Nuclear Energy». IBRAE, Moscow, June 7 - 9 (2004).

Experience feedback from incidents: methodological and cultural aspects

R. PERINET

romuald.perinet@irsn.fr

IRSN/DSR/SEFH

Institute for Radiological Protection and Nuclear Safety (IRSN), Fontenay-aux-Roses - France

Abstract

EdF has designed some provisions to improve the reliability of human interventions: an increased number of training simulators, management of the quality of interventions, implementation of human factor consultants on each site, improvement in user documentation, development of communication practices, etc. However, despite efforts made in the right direction, the complexity of human behaviour and organisations make it obligatory to follow up the efficacy of these provisions over time in order to ensure that they produce the expected results on work practices. The in-depth analysis by IRSN of events that are significant for safety shows that experience feedback from incidents constitutes a real opportunity to ensure this follow-up. It also highlights the difficulty for licensees to define the temporal context of investigations to carry out, analysing errors committed more in depth and identifying ensuing problems. This article shows that these difficulties are the result of inappropriate methodologies and a lack of skills and availability to carry out the analysis. Finally, it shows that the incident leads to defensive behaviour among those participating in the system that blocks the compilation of information and limits the relevance of analyses.

1. Introduction

Tchernobyl 26 April 1986, AZF 21 September 2001, Columbia 1 February 2003.... The occurrence of accidents in risk systems shows the difficulty, indeed the impossibility of foreseeing, given their diversity, all future user situations and of preventing the associated failure modes. This impossibility results from the complexity and relative instability over time of the organisations and technologies involved. Finally, the reliability of the system is based on the capacity of man, who participates as close as possible to materials and procedures, to adapt and manage unforeseen failures. Experience feedback shows that this capacity is limited. For example, during the Three Mile Island accident of 28 March 1979 that led to the partial melting of the uranium core of the nuclear reactor, operators persisted in believing, based on indications provided by the control console, that the pressuriser discharge valve was closed, while it was not.

Provisions should be implemented in order to continuously scrutinise the behaviour of these systems and detect as early as possible, drifts in behaviour or excessive demands made on human capacity. These provisions should enable meeting two major requirements:

- he need to go more into depth into the identification of failed work situations and scenarios that are the precursor of serious accidents whose consideration has not been enabled by design studies,
- and consequently, the need to go further into depth into the evaluation of technical, human and organisational defence lines, improving them and/or limiting the consequences of their failure.

In the nuclear field, the order of 10 August 1984 relating to the quality of design, construction and use of nuclear plants require to declare "significant anomalies or incidents in the shortest time possible" and analysing them more in-depth (reference [1], section 13). However, the repetition of similar significant events shows that the use of experience feedback is a complex process whose performances do not always meet expectations. For example, the Three Mile Island accident "nearly occurred" twice before: once in Switzerland in 1974 and once in the Davies-Besse reactor in Ohio in 1977. Similarly, the Challenger (1986), Zeebrugge (1987), King's Cross (1987) and Bhopal (1984) accidents were all preceded by warnings that

were neglected (reference [2], p288). In this context, this article tackles methodological, organisational and cultural factors that are susceptible of limiting the results produced by experience feedback.

2. Analysis of the incident from the point of view of human and organisational factors

The analysis of an incident from the point of view of human and organisational factors aims to understand its genesis and its progress in order to prevent the repetition of similar situations. The analysis of incidents from the point of view of human and organisational factors is broken down into three principal stages. Each one is dealt with below in this article: compilation of data, analysis of errors and the definition of corrective actions.

2.1. Compilation and formatting of data

The compilation of data is the first stage in the investigation of errors and identification of their causes. From then on, it is important that the context chosen does not exclude a priori any eventuality among possible causes. Once this demand is enacted the question is asked of knowing how to limit the field of investigation. According to Reason (1990), "There are no well-defined rules to restrict such retrospective research...[Generally,] the time taken for retrospective investigation varies: from approximately two years for Three Mile Island to nine years for the Challenger accident. The specified length of the period to consider depends on the particular history of each accident and available sources. In fact, the choice of starting point remains quite arbitrary" (reference [2], p258). In depth analyses of significant events carried out by IRSN show that nuclear licensees adopt a temporal context of analysis that too often does not consider decisions or errors committed within the design of equipment and of working documents or within the preparation of activities.

2.2. Analysis of errors

Following the Tchernobyl catastrophe, the initial information provided by Russian officials caused the entire blame for the accident to fall upon the operators since they insisted on violations of control rules. Analysis of root causes of the accident revealed that these rules were neither clear nor understood and that the main causes of the catastrophe were design of the facility, shortage of safety studies as well as weakness in technical specifications and resulting training. This analysis highlights two types of error: active errors (those whose "effects are felt almost immediately"), and latent errors (those whose "disastrous consequences may remain dormant for a long time in the system and only manifest by combining with other factors to highlight the deficiency in system defences" (reference [2], p239). In general we notice that analysis of active errors by nuclear licensees is satisfactory but this is not the case for latent errors. This shortcoming in particular tends to cause a feeling of fear or lack of legitimacy that is felt by analysts (often the persons committing active errors: operators, field agents...) in relation to authors of latent errors (often engineers, designers, decision makers...).

«There is a strong tendency to defensiveness and secrecy among top managers who feel that event analysis may point a finger at their decisions and actions» (reference [3], p3). Everything occurs as if the incident had triggered an internal crisis, arousing feelings of uncertainty and mistrust that are sufficiently strong as to lead to defensive behaviour: play acting, standardization of the incident, lying, non-disclosure, failing to admit the mistake..... «the natural feelings of guilt, fear and anger engendered by accident and disaster encourage people to respond in that mode [traditional judicial approach], even when they are not standing before a judge» (reference [3], p8). Reason (1990) highlights that the "occurrence of catastrophes in facilities built by man inevitably leads to a search for culpability" (reference [2]).

Finally, the efficacy of experience feedback is also to do with the capacity of the system to identify and process resulting malfunctions or "weak signals". As much as it appears necessary, implementation of this approach leads to difficulties. For example, the "weak" character of signals considered and the absence of the capitalisation tool enabling analysis of their recurrence may lead the analyst to underestimate their importance. Furthermore, the non-deterministic character of human behaviour may lead the analyst to wrongly consider that the resulting malfunction is the result of chance. Generally, the capacity of the system to detect weak signals is essentially to do with the means allocated to analysis (capitalisation tools, benchmark indicators, methods, skills) with the aim sought after by authors of incident reports and the recurrent difficulty for analysts to question and evolve their own explanatory model of human behaviour (in French nuclear reactors, human factor specialists are frequently associated with analysts for the execution of

this stage). These factors arise principally from the culture of experience feedback and from organisational choices made by decision makers in this field.

2.3. Definition of corrective and preventive actions

The Convention on Nuclear Safety states that analyses carried out by licensees involve the "justification of provisions that may be necessary for additional control, repair or modification of user conditions" (reference [4], section 13). We observe that respect for this demand presents discrepancies among licensees leading to frequent incoherences among the causes identified and corrective actions proposed. For example, analysis of the distribution of preventive actions proposed in the incident reports drawn up by EdF highlights a significant proportion of actions relating to documentation (correction of operating ranges, specifications on the role of each one...) and training of actors (information, recall...) while errors too often result from faults related to the organisation of activities (planning, preparation, coordination) and communication. Since we are unable to foresee the errors analysed, these incoherences are, on the contrary, such that they introduce new risks related for example to an abundance in documentation.

3. Conclusions

In this article, the incident is considered as the revelation of preventive needs that no provision up to now has enabled meeting. The identification and processing of these involve comprehension of the process according to which errors are linked and combined, identification of factors causing the errors and definition of necessary improvements to prevent similar situation. Implementation of this approach constitutes an act of analysis and makes it necessary to take into consideration a certain number of minimum requirements that include the following: necessary impartiality on the part of the analyst, methodological indicators, skills and sufficient availability.

These provisions, however necessary they may be, do not take into account the collective dimension of the approach, which is the source of significant bias. Indeed, dealing with incident is at first an act of analysis, through interviews with actors of the incident, and also an act of communication of an incident report within the organisation and towards external organisms (regulator body...). Now, as this article shows, once the incident occurs, it is a source of internal crisis that leads to the development of fears and defensive behaviour that is damaging to the compilation of information: standardization of the incident, lying, non-disclosure, play acting, refusal to admit the mistake...

The analysis of these difficulties shows the importance of the sense given by each one of the hierarchical levels, to the approach to analyse the incident with human and organisational components. In its report on the safety culture (INSAG 4, reference [5]), the IAEA highlights that when errors are committed, they are considered less as a subject of concern as a source of lessons that can be learnt. Consequently, the IAEA recommends encouraging individuals to highlight and correct imperfections in their own work in order to assist others as well as themselves to prevent future problems (p13). 15 years after their publication, it seems that the recommendations of this report are still as relevant today.

REFERENCES

- [1] Arrêté du 10 août 1984 relatif à la qualité de la conception, de la construction et de l'exploitation des installations nucléaires de base
- [2] J. Reason (1990). L'erreur humaine. Traduction française (1993). PUF, Paris.
- [3] Hale, B. Wilpert et M. Freitag (1997). After the event. Elsevier Science LTD, Oxford.
- [4] Décret n°96-972 du 31 octobre 1996 portant publication de la Convention sur la sûreté nucléaire, signée à Vienne le 20 septembre 1994
- [5] AIEA (1991). Culture de sûreté – rapport du groupe consultatif international pour la sûreté nucléaire. Collection sécurité n°75-insag-4. Vienne.

The building of a Pluralist Expertise Group about uranium mines in Limousin (France)

Didier GAY

IRSN, BP 17 – 92262 Fontenay-aux-Roses Cedex - France

Abstract:

Uranium mining and milling industry once played a major strategic and economic role in France. After the definitive cessation of mining and milling activity in 2001, more than 200 sites are currently under closure and post-closure phases. Decisions required in this frame raise particular difficulties because of the sensitivity of some technical issues and the strong scrutiny and requirements of local and national NGOs. This is particular true in Limousin, the region that stands for the cradle and the heart of the national uranium history. In order to deal with this complex and disputed topic, the ministries of environment, health and industry recently decided to set up a pluralist expertise group with the aim to come to analyze and give a critical point of view on the various technical documents prepared by AREVA NC about the surveillance and control of its mining sites in the department of Haute-Vienne in the Limousin region and then provide recommendations to public authorities to improve current situation.

1 THE CONTEXT

1.1.1 Historical perspective

Uranium exploration and exploitation started in France soon after the end of 2nd world war. It gradually grew in importance from this period to the 80s. From the end of the 80s, it then rapidly declined under the combined effect of exhaustion of reserves and fall of uranium market prices. Activity came to a definitive end with the closure of the last mine in 2001.

During more than 50 years, more than 200 sites scattered over a large part of national territory where prospected and put in production. Most of them and at least the most significant ones in terms of quantity of uranium produced are localized in four main districts: le Limousin in the western part of the Massif Central, la Vendée in the west of France, l'Hérault in the South of the country and le Forez in the eastern part of the Massif Central.

French sites yielded a total of 76 000 tons of uranium which represent more than 10 years of the current needs of the national power plants. The milling of ores involved the operation of 8 uranium processing plants and produced more than 50 000 000 tons of tailings. These tailings are disposed in 17 specific repositories.

Closure works are now completed at most sites and remaining activity mainly consists in surveillance and control and in the maintenance of several water treatment facilities.

1.1.2 Particular place of Limousin region

Among the various districts that contributed to french uranium production, Limousin region clearly played a particular role. Limousin is indeed the cradle of the national uranium history: it was on its territory that the first exploited ores were found in 1946. It was on its territory too that the last mine closed in 2001.

Limousin region also played a leading position all along the 50 years of activity. It yielded nearly one third of the total national production and hosts 5 of the 18 tailings repositories (that represents roughly half of the total mass of tailings produced). One of its former mining site also hosts a storage facility for depleted uranium produced by the French fuel cycle facilities.

Limousin region witnessed several of the media crises experienced by the French uranium mining industry. It also hosted the first prosecution of a nuclear operator before a criminal court after a judicial inquiry was initiated against AREVA for "pollution, abandonment and dumping of waste containing radioactive substances" at several sites located close to old uranium mines in the Haute-Vienne department.

2 STACKHOLDERS POSITIONS AND EXPECTATIONS

2.1 AREVA NC

Following the merging and acquiring of the different companies involved in the exploitation of uranium ores, AREVA NC (formerly well known as COGEMA) has become the only industrial actor in this sector in France. Practically, it is now responsible for the management, monitoring and surveillance of the roundly 200 sites mentioned earlier.

Uranium mining is still in the core of AREVA industrial activities, production is however nowadays entirely located abroad. In France, practical involvement of the group on the former mining districts consists of addressing social and environmental legacy. From this point of view, sites can be considered as a burden; the question is then raised of how the sites can be definitively closed and relieved from regulatory control. In other words, background question is how to sell out this legacy and quit the game.

From another point of view, social and environment legacy is also a potential threat to AREVA's image as a sustainable company. This aspect is all the more significant that aside its mining activity AREVA group is also one of the major company in the nuclear business both in France and worldwide. As a nuclear actor it is at the center of a strict scrutiny from various stakeholders including environmental NGOs but also politicians and media. This context urges AREVA to fully respect its duties and even act in a proactive manner.

2.2 National and local NGOs

Concerns and interests of NGOs in the former uranium mines find their roots on the one hand in the willing to defend local quality of life and environmental protection, on the other hand in an attempt to stress the failures of an industrial actor considered as a member of the "nuclear lobby" and this way to shift to a general debate about nuclear energy.

Uranium mining is thus often pointed out today as the weak point of the nuclear industry. It is notably acknowledged to account for the largest part of public exposure due to fuel cycle facilities, far behind the exposure usually attributed to nuclear power plants or even spent fuel reprocessing. Moreover the management of uranium mining and milling waste and particularly the long-term safety issues associated with the 17 tailings repositories and the 50 million tons they contain has found a natural place in the national debate about nuclear waste and the most adequate national frame to regulate and control nuclear activity. Not surprisingly, the topic has progressively become a particular topic of concern and interest for national NGOs involved in the world of radioactivity.

In addition to this general context, the last decades of the French uranium mining history knew a series of local disputes between NGOs and AREVA. These disputes that eventually came to media or even judicial field globally contributed to raise suspicion and weaken the trust of local populations towards AREVA.

Transport and disposal of wastes coming from other regions, others steps of nuclear cycle or other TENORM¹ industries were at several occasions denounced as unfair and unacceptable practices. They were considered as an attempt by mining companies to take benefit of too fuzzy regulations and too accommodating enforcement of laws to convert old mining sites into national nuclear waste disposals.

In parallel, NGOs (along with official reports written in answer to administrative bodies or parliamentary offices) challenged the regulatory status of several tailings repositories and argued they should be regulate as nuclear installations based on the total amount of activity they contained.

At last, several cases of enhanced levels of radioactivity in the vicinity of mining sites were pointed out as a proof of inadequate management of mining and milling wastes or inappropriate control and treatment of water discharges. Dissemination of spent rocks (or very low grade ores) and their reuse as construction materials were thus acknowledged to cause high radon concentrations (locally up to 10 000 Bq/m³) in an industrial building. In other places, the sediments of several ponds including a lake dedicated to recreational activity and ponds used to produce drinking water were found to present high concentrations in uranium.

2.3 Local populations

¹ TENORM: technologically-enhanced naturally occurring radioactive material

Former uranium mining districts are mostly located in low-populated areas, sites being themselves in countryside. Local populations are therefore mainly rural and uranium mining and milling were once a major source of wealth and employment. Social and economic impacts were therefore significant and expectations from AREVA NC to support new industrial development during a transition phase were high. More than 5 years since the last site closed and several decades after French uranium booming, this question is probably not as sharp today as in the past.

Concerns or at least questioning can nonetheless be locally strong about environmental impacts and their potential economic side-effects. Green-tourism indeed often plays a particular importance and could easily suffer from being associated with pollutions; especially if radioactive.

2.4 Local and national administrations

Several national administrations are involved in the old uranium mining issue. As any mining activity, the issue first falls under the responsibility of the ministry of industry and more particularly of the department in charge of defining the guidance and regulations relative to the closure and post-closure management of mining sites. But it lies also in the liability of the ministry of ecology and sustainable development notably because tailings repositories are regulated as installation classified for environmental protection purposes. In this particular field, it played an active role in defining guidance for the control and surveillance of the sites concerned but also gave strong incentives to improve public information and promote independent review of AREVA NC reports. At last, the ministry of health and the nuclear safety authority is also involved in the issue through its general competence to propose nuclear policy and regulations.

At local levels, administrations struggle between the need that the post-closure works and administrative procedures may proceed forward and the claim from NGOs and local populations to get a clear statement about actual impacts on man and the environment before any decision to go further. One particular difficulty they encounter is linked to the accusation of being too accommodating towards AREVA NC launched by some NGOs.

3 THE ORIGIN OF THE PLURALIST EXPERTISE GROUP INITIATIVE

3.1 The GRNC experience and the opening up of IRSN expertise

In 1996, an epidemiologic study by the professor J.F. Viel's team from the University of Besançon published in the British Medical Journal established the existence of a trend towards an excess number of leukemia in the canton of Beaumont-Hague, close to AREVA reprocessing plant. The study suggested a relation with the consumption of seafood and time spent on the beach and led public authorities to ask for a more detailed radioecological analysis in order to produce a direct and best estimate of the radiological exposure of the population and corresponding predicted effect on health.

Annie Sugier, Director of radiation protection at IRSN (formerly IPSN), was commissioned to form and preside over the group of experts in charge of carrying out this work. The group, known as the "Nord-Cotentin radioecology group" (GRNC) included experts from a wide range of origins (inspectors, operators, governmental experts, experts from non-governmental laboratories as well as foreign experts). After two years of work it addressed its conclusions to the ministers of environment and health and closed a first phase of analysis by issuing a series of detailed reports now considered as reference documents.

This rather unique experience in France really marks the beginning of a resolute IRSN strategy to open up its expertise to civilian society in order to deal with complex or disputed topics. This approach to involve the interested parties is largely consistent with the guideline adopted by the French government for greater transparency in the field of nuclear and radiological risk management.

3.2 The GEP mines: origin and organization

Following the GRNC experience, a discussion was initiated between IRSN and interested public administrations to engage a new initiative of pluralist expertise about potentially interesting topics including the question of old uranium mines. This proposal raised interest from the three competent administrative bodies in charge of this latter issue: the ministry of ecology and sustainable development, the ministry of industry and the ministry of health. Practically it led to two different initiatives: one from the local administration in charge of regulating the sites, another from national administrative bodies.

At local level, the prefect of Haute-Vienne requested AREVA NC to prepare a ten-year environmental report about the surveillance and control of mining sites located in the department. This report was issued at the end of 2004². In order to get an expert opinion about its content the prefect then asked AREVA NC to produce an independent review of the report with the aim to give a particular focus on five different topics:

- the sufficiency of the closure and post-closure works already done on the sites regarding middle and long-term radiological safety issues;
- the assessment of environmental impacts associated to mining activities, especially those linked to water discharges, and the sufficiency of solutions implemented by AREVA to prevent and limit them;
- the adequacy of radiological calculations done by AREVA NC to evaluate the added exposure received by populations living around the sites;
- the soundness of control and surveillance provisions with regard to the occurrence of enhanced levels of radioactivity in specific compartments of the environment;
- the potential dissemination and use of mining and milling wastes for private or public works.

IRSN has been entrusted to carry out the corresponding review.

At the national level, the three ministers asked Annie Sugier to form and preside over a new pluralist expertise group aimed to analyze and give a critical point of view on the various technical documents prepared by AREVA NC about the surveillance and control of its mining sites in the department of Haute-Vienne in the Limousin region. One particular document is the ten-year environmental report mentioned above.

According to the mandate given to the group, one particular expected output is to assist public authorities to identify the available options for post-closure plans and to provide recommendations on the possible solutions to minimize existing impacts on the environment and the local populations.

In order to fulfill these objectives, the group is expected to carry out its own work but also to steer and take benefit of the review of the AREVA NC ten-year environmental report entrusted to IRSN.

After necessary consultations of local and national administrations, potential experts but also main stakeholders (including leading national and local NGOs), a list of a dozen of members was established and a first meeting was organized late June 2006. Scientific backgrounds of the members of the expert group relate to earth sciences (hydrogeology, geochemistry, mining), metrology of environmental radioactivity, radioecology and radiation protection. The group includes experts from French public organizations but also foreign experts, experts from non-governmental organizations and representatives from AREVA NC.

Following the first meeting, the experts decided to form three working groups each dedicated to a specific topic. The first one deals with source-term, discharges and transfer to the environment. It aims to review the main processes involved and the way AREVA NC took them into account in its studies and reports. The second working group deals with environmental and health impacts. The group examines the approach handled by AREVA NC to evaluate impacts to man and the environment around its sites but also aims at providing guidance on the need and feasibility of setting up health surveillance provisions to complement the dose assessments currently carried out by AREVA NC. The third group intends to provide a broader view to the expertise work by addressing the question of regulatory framework and adequate requirements to ensure health and environmental surveillance today and in a long-term perspective. In a first step work is focused on the analysis of the many public reports dedicated to this issue.

² see extended summary available on the web site of the DRIRE Limousin
<http://www.limousin.drirc.gouv.fr/environnement/cogema/BILANDECENNALENVIRONNEMENTALRESUME/resume-BDE.pdf>

4 TECHNICAL QUESTIONS AND NON TECHNICAL EXPECTATIONS

Contrarily to GRNC or other international initiatives dedicated to old mining sites, the question addressed by GEP mines is not heavily focused on one single sharp technical issue. It is rather a combination of many concerns, stakes and objectives that end up with a complex and disputed situation. Among this complexity and diversity of issues a few can be stressed as key questions.

From a technical point of view, these key questions generally relate to the evaluation of an added dose in a context of natural radioactive background, to the occurrence of locally enhanced concentrations of radioactivity in the environment and their potential impacts on man and biota and to the necessary provisions to ensure long-term safety especially as far as tailings repository are concerned.

Previous questions are quite generic and have already been addressed in a theoretical (and sometimes practical) way at different occasions by international organizations and a few foreign countries. In the case of the GEP mines they have to be tackled in a particular context where technical positions supported by AREVA NC and sometimes regulatory practices have been challenged by local and national NGOs and a climate of mistrust has progressively settled. This clearly requires a particular care to hear and understand various opinions and concerns and to properly inform and explain technical positions that will be taken. This information and explanations are not only required to the administrations that initiated the creation of the expertise group but also to the various other stakeholders. In order to more fully answer to these expectations, the 3rd working group has decided to enlarge its composition to more closely involve the various points of view expressed in the successive debates including judicial ones.

In addition, GEP mines must contribute to the expectations of public authorities by providing practical guidance to proceed with closure and post-closure administrative procedures in a way widely discussed and accepted.

Given the many different sites and situations to cope with, both IRSN and GEP mines decided to first focus their technical work on two specific issues. One is related to the tailings repository of Bellezane, the other to the environmental impact at the scale of the watershed of a local stream called Ritord. The expertise about Bellezane repository has notably addressed the question of hydraulic functioning of the disposal system and the potential existence of leakages; it has also assessed the efficiency of the waste rocks cover with regard to the attenuation of external gamma dose rates and radon exhalation rates. The expertise about Ritord watershed has assessed the question of the origin and evolution of the sediments enhanced uranium concentrations (up to several 10 000 Bq.kg⁻¹) measured in the estuary of the stream into an artificial lake. It has also examined the information available to evaluate the potential impact of mining activities to species and biota.

After nearly 6 months of work, GEP mines intends to deliver a first interim report at the end of this year. This interim report will provide some technical insights about the two specific issues mentioned before and define the roadmap for the continuation of the work.

"Openness to civil society: the challenges for the TSOs"

Mickaël Petitfrère, François Rollinger
IRSN, France

Abstract

Society's concerns have led to changes in the legal framework towards a greater requirement for public information and participation in decision-making processes.

International organisations such as the OECD/NEA and the IAEA have also made similar changes.

What changes are necessary to the way TSOs work to make space for a fourth player – the population – in controlling radiological and nuclear risk?

Society's participation varies from access to existing information to a desire to participate in expert assessments in a pluralistic assessment process.

IRSN has made openness to civil society one of its four strategic priorities, and a dedicated team is responsible for carrying out actions in consultation with players from civil society, including the local information committees (CLIs). These actions lie at the heart of IRSN's strategy, because it is only by developing experimental expert assessment processes involving parts of civil society that both sides can learn from one another.

Two pluralistic expert groups have been set up on radiological protection, and their innovative method of operation is worth highlighting.

Another participative action is the development jointly with the CLIs in the Loire basin of methods of collecting environmental monitoring data.

Finally, to accompany and promote this new approach internally, an internal network dedicated to stakeholder involvement has been set up. IRSN also intends to take advantage of existing experiences elsewhere.

These moves towards joint expert assessment are an inevitable development that demands a real change of culture on the part of all players, putting technical issues as part of a broader process of evaluation and decision-making. Actually, they form part of a sustainable development approach.

1 - Stakeholder involvement, a change required of everyone:

Society's concerns about the consequences for health and the environment of human activity, particularly industrial activity, date back about thirty years and follow a series of catastrophes (Seveso, Bhopal, Chernobyl, etc.). They have led to changes in the legal framework towards a requirement for public information and participation in decision-making processes (Aarhus Convention, Environmental Charter incorporated into the French Constitution). Nuclear has not escaped this trend (French Nuclear Safety and Transparency Act passed in June 2006).

In parallel, international organisations have evolved and now recognise the importance of the involvement of stakeholders, including those from civil society, in preparatory processes for decision-making on radiological protection and nuclear safety.

The OECD/NEA has devoted much work to this question since Villingen in 1998 and is preparing a report for mid-2007 on how radiological protection institutions have evolved with respect to stakeholder involvement.

The publication of the INSAG 20 report entitled "Stakeholder Involvement in Nuclear Issues" by the International Atomic Energy Agency also bears witness to this. In this report, the place of local players in the decision-making process concerning site selection and the construction of nuclear power plants is clearly recognised.

Against this background of widespread change, expert bodies in nuclear safety and radiological protection have had to make changes in their ways of working to contribute to this in their own way, as assessors and not decision-makers.

2 - The role of the TSOs

In France, controlling radiological and nuclear risk has historically been structured around a technical dialogue between three players: the operator, the expert body and the control authority; although evaluation and decision-making in other countries may be performed by the same institution, the functions nevertheless remain separate.

What changes to this process are necessary to make way for a fourth player, the population, to participate through the environmental protection associations and local information committees that exist in some countries?

The participation of civil society can vary in degree, from the simple request for access to existing information to the desire to participate in expert assessments. Access by public concerned to expert assessment documents produced by the TSOs is the first level of expertise-sharing and could be described as "passive transparency". The second level involves consulting stakeholders early on in the process by including them, for example, in the preparation of specifications for an expert assessment or in an assessment process between the industrial company and the institutional authority or expert. Civil society can also provide critical or alternative expert assessments. Finally, the most sophisticated method of involvement is the pluralistic expert assessment. Specialists from all the disciplines involved and stakeholder representatives proceed step-by-step with risk assessment.

Pluralistic assessment processes clearly demand the most profound changes in the working methods of TSOs and require the most resources. But there is also debate over access to information during technical reviews. Although the principle of making public the opinions TSOs deliver to authorities is rarely challenged, final decision-makers may feel uncomfortable at the prospect of having to justify their decisions if they differ from the opinion of the TSO. Yet the aim of this openness to society is not to weaken decision-making but make it more effective and comprehensible as a result of being better informed through the involvement of stakeholders.

3 – The IRSN's experience regarding openness to civil society

The Institute for Radiological Protection and Nuclear Safety (IRSN) was set up as a public institution independent of operators and separate from the control authority in 2002. Since its creation, it has made openness to civil society one of its strategic priorities, written into the target contract every French public body signs with the government. This approach covers a wide variety of initiatives aimed at changing its relations with the outside world by responding to the needs of other economic and social players in terms of information, expertise and research. To achieve this, IRSN has committed itself to:

- making reference information public and being identified as a credible source of scientific and technical information by opinion leaders;
- contributing to education and training on nuclear safety and radiological protection;
- undertaking actions aimed at civil society by making its expertise available to local information committees (CLIs) or equivalent organisations and by launching "pluralistic expert assessment procedures" at the request of the public authorities;
- carrying out studies on behalf of companies and public or private bodies.

With the prospect of developing these activities, a special division for openness to society (DOS) has been set up within the Strategy Sector. This division has particular responsibility for:

- promoting the Institute's position by producing reference documents as part of a transparency policy;
- engaging in participative actions (external expert assessments, "participative" pilot initiatives, etc.) with players from civil society, including the CLIs, which it defines and implements with the experts concerned.

These participative actions are at the heart of IRSN's strategy to develop an open approach to society with regard to its work. These practices are new and it is by developing experimental expert assessment processes involving parts of civil society that the representatives of society and IRSN's researchers and experts can learn from one another.

Among these actions, two pluralistic expert groups (GEPs) are worth particular mention. They were set up at the request of the French radiological protection authorities. They are the Nord-Cotentin Radioecology Group (GRNC) set up in 1997 following the scientific dispute triggered by the observation of a high incidence of leukaemia around the COGEMA La Hague reprocessing plant, and the pluralistic expert group known as

"Around the mines in Limousin", the purpose of which is more precisely described in the contribution of Didier Gay.*

IRSN provides both logistical and scientific support for the work of these groups. There are two points we feel should be highlighted. The first is the initial consultation with the various stakeholders on the missions of the GEP itself. The second is that there is no obligation of consensus within the group, and that the technical dialogue between scientific experts from a variety of backgrounds (institutions, industry and associations, whether French or foreign) means that reasoned opinions, identifying explicitly both points of agreement and uncertainties and differences of opinion, can be issued for the benefit of national public authorities, the local information committees (CLIs) and local authorities.

These participative actions do not necessarily originate as a result of controversies. The pilot action on the environmental impact of the four nuclear power plants in the Loire catchment basin was set up for two reasons. On the one hand, IRSN has a general mission to provide a radiological protection watch, and it takes many radioactivity monitoring measurements in the environment and wishes to make them as accessible as possible to the public. On the other hand, the quality of environmental monitoring of their areas was one of the primary causes of concern identified in 2004 in a survey of the CLIs. The aim of this action, which began in 2005, is therefore to set up environmental monitoring data collection methods jointly with the CLIs in the Loire basin, and provide local players with intelligible information by means of relevant indicators enabling them to monitor the quality of their environment themselves.

In addition to these participative actions it is developing itself, IRSN also wants to take advantage of existing experiences, particularly through the development of national, European and international networks. The division for openness to society (DOS) is therefore also responsible for participating in research in this area with national and international partners, and for conducting studies such as the IRSN barometer of risk perception.

Finally, to accompany and promote this new approach internally, the DOS is running an internal network of experts and researchers, which provides room for discussion of current initiatives and proposals to the management on openness to society.

4 – Conclusion and future operations

Opening expert assessment processes up to stakeholders is an inevitable development that demands a real change of culture on the part of all players (operators, experts, authorities, associations, elected representatives, etc.). Although this change may not affect all the work of the TSOs in any particular depth, it does require in complex cases profound changes in the way we work. It is now essential for technical issues relating to radiological protection and nuclear safety to undergo a more comprehensive evaluation and decision-making process incorporating ethical issues as well as economic and social ones.

Although this change is not without its difficulties, IRSN's experience shows that by promoting initiatives that gradually change attitudes among internal and external partners, success can be achieved with:

- working together to prepare for decision-making by clarifying the technical and also the social challenges;
- making these decisions more efficient and better understood as a result.

More broadly, the move towards joint diagnosis and expert assessment ties in with a sustainable development approach.

There is still a long way to go, but to continue making progress it is essential that we share our successes and our difficulties with the national and international networks dedicated to these questions. Support from international organisations such as the European Union, the OECD/NEA and the IAEA will be very valuable in this regard.

IRSN and the period safety reviews related the ten-yearly outages of French nuclear power plants

Martial LE CARRER

ABSTRACT:

The periodic safety reviews (PSR) are important steps in the operation of the French nuclear power plants. The main objectives are:

- To verify the conformity of the nuclear power plants to their current safety requirements, by means of standard safety studies and of a conformity verification performed at each unit of the series,
- To enhance the safety level taking into account more recent safety requirements.

The PSR process jointly developed by Electricité de France, IRSN and the Nuclear Safety Authority is now well-defined and operational.

The PSR assessment is an important part of the IRSN activity of safety and technical expertise. To provide an objective and well-argued expertise, notably for the safety referential reassessment, the challenges of IRSN are to keep and develop his competence and knowledge about the various technical and safety topics, to collect and analyze operational feedback and to define and realize appropriate research and studies programs.

TEXT:

In France, the nuclear installation operating licences are granted without a time limit. However, the Regulator may request units to take at any time executory measures intended to ensure safety, including suspension of the operation of the installation, and also requires that the licensee performs a periodic safety review (PSR) of his installation every ten years. The objectives of the Regulator are that the licensee improves periodically the safety and proves the real conformity of his installation before the end of each ten-yearly outage.

The finalized PSR general process has been proposed by Electricité de France and has been assessed by IRSN and the standing group of experts (meetings of June 2003). Now this process is well established and has shown its efficiency to the second ten-yearly PSR of the 900 and 1300 MWe series and the third ten-yearly PSR of the 900 MWe series which is started.

The IRSN assessment of a PSR is an important activity involving many experts and many topics. After twenty years of operating experience, a typical PSR (including the build-up of the program) related to a ten-yearly outage of a French nuclear power plants series lasts six years. Its scope includes a large number of various technical and safety topics and requires the appropriate competence, knowledge and access to international operational feedback and research results.

The main steps of the PSR are given in the following paragraphs. At each step, IRSN assess the studies, documents (safety analysis report) and propositions (program of the PSR and modifications) of Electricité de France and submits his analysis and conclusions to the standing group of experts and the Nuclear Safety Authority. In some cases, IRSN has also to implement his own studies and research programs necessary for this assessment.

Build-up of the program and objectives

The program and objectives of PSR are proposed by Electricité de France. But, by his questioning attitude, IRSN participate also to their build-up.

The program and objectives of the PSR is strongly influenced by the knowledge and safety practice evolution as well as the operating experience feedback analysis, be it national or international. Their build-up is very important to avoid any misunderstanding between the nuclear operator and the Regulator during its performance and is also a strategic phase because it must define the scope of the studies to be performed as well as the safety level to be reached.

Identification of the safety referential to be used for the safety conformity examination

The identification of the set of reference safety requirements (called “safety referential” in the following) constituted by the rules, criteria and specifications applicable is also a significant phase of the PSR. It is important to notice that for the first French PSR, this phase led to long debates between the Nuclear Safety Authority, IRSN and Electricité de France. It highlighted the importance of having before the start-up of a PSR an updated and approved version of the safety analysis report. The safety requirement referential is constituted by a number of regulatory documents and accompanying texts that follow this hierarchical order (regulatory pyramid):

- Laws, decrees,
- Approved safety analysis reports,
- Approved general operating rules and associated documents (internal emergency plans),
- Surveillance rules of operating mechanical equipment.

Conformity examination

The conformity examination consists of a comparison of the safety level of the installations with their initial level, i.e. the level for which the operating licence was initially granted, which makes it possible to check that this level has not changed and that therefore, the requirements of the operating licence are still being met. This examination is intended to identify any deterioration or design and manufacturing defect of the installation, and to examine the weak points of the safety evaluations that require additional analysis or justifications.

Therefore the conformity examination is split in two parts:

- The verification of the conformity of the reference safety studies, as described in the safety analysis report, with the applicable safety requirements (conformity studies),
- The verification of the actual state of the nuclear power plants against their reference state given by the safety analysis report (nuclear power plants conformity check).

In addition to the verification of the actual state of the nuclear power plants against their reference state, a complementary investigation program is settled. The objective of this program is to check the conformity of equipment not included in the preventive maintenance programs and eventually to identify maintenance domains to be completed. The investigations are implemented on site at the time of the ten-yearly outages.

The scope of the conformity examination (in all its aspects) is defined on the basis of the operating experience feedback analysis (national and international), of the expertise evolution in safety analyses and of the feedback of the previous PSR.

Safety referential reassessment

The objective of the safety referential reassessment is to bring the safety of the units up to a higher level than the initial design and that achieved by continuous analysis of operating experience feedback, taking into account, as much as possible, progress resulting from the knowledge progress.

Safety reassessment applicable to the nuclear power plants to be examined may differ somewhat from those applicable to the newest nuclear power plants in operation and from those planned. Therefore, in order to launch the safety reassessment studies, the identification and analysis of such differences must be conducted in the most exhaustive possible way.

Then, the need to fill the identified gaps must be examined on a case-by-case basis, in order to evaluate the importance of each gap in terms of the global safety level of the installation. The advantage of changing the safety referential and eventually the installations must be examined taking into account on one hand the potential safety benefit and on the other hand the technical and economic feasibility.

Definition and implementation of the ten-yearly modification batch

After completion of the safety reassessment studies (safety referential reassessment and conformity examination), the operator sends to the Nuclear Safety Authority a document that describes all the modifications (hardware and document) to be implemented to satisfy the conclusions of the safety studies. A need for additional modifications may appear beyond the framework of the PSR as for example modifications deemed necessary to be implemented through the analysis of operating experience feedback.

The PSR process is designed as to enable the operator to plan the modification implementation during the ten-yearly outages. However some modifications can be implemented earlier if they are selected as very high in terms of safety or address generic discrepancies detected on the units.

For example, the replacement of filtering devices of the recirculation sumps which is a generic urging modification decided in 2003, is now being implemented on French nuclear power plants without consideration of their ten-yearly outages.

Safety analysis report

The main objective of the safety analysis report (SAR) is to present to the Nuclear Safety Authority, the nature of the installation, its intended use, but also the updated safety evaluations performed to check that there is no unacceptable risk to the health or safety of the population. The SAR is a contractual document between the nuclear operator and the Nuclear Safety Authority, which has to be fully respected by the operator.

Within the framework of the PSR the operator has to write a new edition of the safety analysis report. This new edition must be sent early enough for it to be assessed by IRSN. On the basis of the PSR and SAR assessment, the French Nuclear Safety Authority approves (or not) the operating of the nuclear power plants until their following ten-yearly outages.

How to evaluate the effectiveness of safety assessment in the area of human factors?

G. ROLINA & JC MOISDON

gregory.rolina@mines-paris.org , jean-claude.moisdon@cgs.ensmp.fr

CENTRE DE GESTION SCIENTIFIQUE

Ecole Nationale Supérieure des Mines de Paris - France

F. JEFFROY

francois.jeffroy@irsn.fr

IRSN/DSR/SEFH

Institute for Radiological Protection and Nuclear Safety (IRSN), Fontenay-aux-Roses

FRANCE

1. Introduction

The Three Mile Island nuclear reactor accident in 1979 led to a new approach regarding safety that includes a better consideration of man and his activities. A few years later, with the set up of a group of specialists at Electricité de France and at the Institute for Radiological Protection and Nuclear Safety, a new player appeared at France's nuclear safety organisation: the assessment expert specialising in human factors (HF). The improvement of man-machine interfaces was one of the first projects undertaken by the HF experts, the majority of whom specialise in ergonomics. A review of the literature and analysis of the archives, [1] revealed that the specialists' scope of investigation has since increased; so that organisation is also the subject of HF assessment. However, this area is not one of consensual or established knowledge; neither researchers nor specialists can agree on a model of safe organisation.

What then can we say about effectiveness of HF assessment? How can we define the criteria of effectiveness of a safety assessment production system in this area? The question is the subject of original research based on collaboration between the scientific management centre (CGS) of the Ecole des Mines in Paris and the section for the study of human factors (SEFH) at IRSN.

To address this question, the CGS team monitors some assessments to which SEFH contributes. In other words, it attends different meetings on framing, technical instruction, reporting, taking notes and collecting related documents (minutes of meetings,...). It carries out additional interviews with different parties involved in assessment in order to ascertain their point of view. A sample of five assessments was defined to cover a varied number of situations encountered by the team of HF experts. The type of facility, the operator and the subject concerned are some of the variables integrated for this choice.

2. The HF assessment production system

The research team has already monitored three assessments. This investigation has led to the proposal of a preliminary characterisation of the "assessment production system" that constitutes SEFH.

Within the IRSN departments dedicated to nuclear safety assessment, two types of population can be found: specialists and generalists. This distinction is quite an old inheritance from the organisation of nuclear safety in France as witnessed by this extract from an article written in 1974 by a former head of department: "Generalists, grouped by reactor system (light water, fast neutron reactors, etc.) are responsible for

evaluation of the safety of each of the facilities subject to examination (...). The experience acquired by these generalists, deals in large part in the development of their judgment. They are, in effect, in charge of constantly keeping all the knowledge acquired on safety in the subsidiary to which the facilities examined belongs up-to-date, and this under both normal conditions and incidental or accidental conditions. To fulfil this mission, the generalists should be concerned with maintaining close relationships with operators. Nonetheless, technical problems posed to generalists by facilities call upon so many disciplines that it is also necessary to have a group of specialists in these disciplines." [2]. SEFH covers one part of this group of specialists.

Here then is a first source of requests for the SEFH: generalists, solicited by the safety authority, call on SEFH specialists for assessments relating to a facility (commissioning, re-examination of safety, etc.). The SEFH specialists have, for example, contributed to the re-examination of the experimental safety reactor, Masurca, located on Cadarache CEA Center. Initial cooperation between the generalist and the SEFH specialist was needed to set out the framework of the instruction in order to determine the subjects that would be examined. For example, the organisation of operating experience feedback, operator document management and the quality of interfaces between different actors at the facility have been integrated into the scope of the assessment.

SEFH specialists can themselves carry out assessments on subjects considered specific to human factors and applicable across several facilities. They are therefore directly requested by the safety authority with which they draw up the framework for the technical instruction in the course of several meetings. This was the case for an assessment covering PWR operating personnel skills management at EdF. During the pre-analysis phase, the discussion addressed questions on which the assessment experts had to provide conclusions, on data gathering and data analysis methods to be implemented and on planning. Possible EdF reactions to instruction methods were envisaged ("Will they accept so many interviews?"). During a framework meeting, HF experts debated with EDF representatives in the presence of the safety authority in order to agree upon the "scope of the instruction". EDF wanted to exclude certain issues from the instruction: "the assessment covers skills management, not the salary policies of the company. The human resources management should be considered as a contextual element". This scope accepted by HF experts and the safety authority was ratified by the "framework letter". Five "safety sensitive professions" and three production sites were defined to carry out a survey of practices related to skills management.

Once outlined, the instruction could start. To assess operators' skills management, approximately one hundred interviews were held by different HF specialists. A previously-developed question and answer grid for a skills management process served as a guide for the interviews. For the contribution to the aforementioned re-examination of safety, the expert could visit the facility and organise two technical meetings during which the CEA representatives answered a questionnaire. This questionnaire had been prepared by the SEFH specialist, which had validated it together with the generalist directing the assessment.

Once the technical instruction finished, the HF expert wrote up his analysis and drew up some recommendations. A lengthy round of revisions led to a new phase of assessment where successive versions were updated by means of very intense discussions between HF experts and their hierarchy.

In both cases, the report and the different recommendations formulated by the experts were then sent to the operators who had the opportunity to respond at a final meeting, called a "preparatory meeting". The operators accepted some of the recommendations and committed to implement them. Cases of disagreement were then debated within the "Permanent Group of experts" whose members are selected based on their competence. Some of them are retired; others are still active with an operator or the IRSN. For several years a determination to improve transparency has been reflected in the appointment of foreigners or safety specialists from other fields (e.g. air, rail). At the end of the meeting, members of the Permanent Group drew up their conclusions destined to the safety authority. The safety authority is the final arbiter of the process. It is this institution that draws up a follow-up letter that (momentarily) brings the assessment process to an end.

3. Three types of HF assessment effectiveness

These descriptions, somewhat simplified, on the production process over a period of several months, illustrate the complexity of relations between different stakeholders in French safety assessment, the organisation of which is sometimes described as "French cooking" on the other side of the Atlantic. How then can we evaluate the effectiveness of such a system?

We propose three concepts of assessment to which different effectiveness criteria may be associated: evaluation assessment, action assessment and apprenticeship assessment.

Evaluation-assessment corresponds to the "emergent side" of assessment. It stops at appreciation of the expert's report and in particular at its conclusions, by the various parties, particularly members of the Permanent Group. Quite traditional quality criteria can be associated with such a conception of assessment: respect for deadlines, clarity of presentations, volume of reports, and number of recommendations taken up by the Permanent Group. Such criteria may seem superficial, nevertheless it is rare not to hear at the beginning of a meeting of the Permanent Group an observation on the number of pages of the IRSN report. A representative of the safety authority insisted on the importance of respect for deadlines: "efficient assessment should arrive in time to support the Safety authority decision." Finally, the clarity of presentations is one of the evaluation criteria used by an IRSN official. Furthermore, the effectiveness of *evaluation-assessment* increases with the legitimacy of expert judgments. A judgment that is accepted by different expert parties is legitimate: its hierarchy, operators, and Permanent Group experts. Therefore, assessment for which the operator accepts all the requests formulated is efficient according to this concept.

Two other concepts of assessment support other notions of effectiveness that are less easily to explain. The effectiveness of action assessment is a function of specific changes triggered by expert/operator interaction during the technical instruction on operator representations, indeed on daily operator practices. Two reasons lead us to support such a concept of effectiveness: the operator is the final link in the chain, the person who applies requests with more or less motivation; they are also responsible for the safety of facilities. Despite the interest we show in this concept of assessment, we note that the expert has little visibility over action assessment; it is mainly after they have finished their work that this type of effect manifests itself. Once the assessment was over, the research team met different operators in order to identify the consequences, if any, of the assessment. They sometimes replied, "We have learnt things, we did not think we had such a problem", "we use your report frequently", and sometimes replied "we would have done this anyway, and the request does not change anything".

Finally, the effectiveness of apprenticeship assessment is a growing function of new knowledge acquired by the HF expert. It depends a lot on the relationship between the expert and the operator. This is particularly the case in the field of human factors where knowledge is incomplete, based on chains of unstable and singular causality (laws often depend on a historical and geographical context) [1]. A demanding encounter with the field is necessary. This feeling is shared by several officials that we met at IRSN: "what is important is that SEFH specialists have hands-on experience." They come under the French tradition of "French cooking" as witnessed by François Cogné, former Chairman of the Permanent Group: "I believe that it is important for safety matters for people responsible for safety to be people with knowledge. (...) Safety is a technique. First and foremost it is a technique. Knowledge of the entire technology of facilities arises from this." [3] The acquisition of this knowledge makes it necessary to set up a close relationship between the expert and the operator.

4. Conclusion

The organisation of nuclear safety in France enables IRSN experts to acquire a detailed knowledge of facilities, knowledge that is particularly crucial in the field of human factors. It has disadvantages however. Restriction of means in particular: assessment that requires a close relationship with the field is certainly more costly than simple documentary control. Furthermore, such organisation is often singled-out or pilloried like a demonstration of the power of a nuclear lobby. We require a more transparent model in which the expert who is pure and independent will use knowledge to give their opinion. But how can they acquire knowledge without learning?

References

- [1]: Grégory Rolina (2006), "Savoirs et relations de l'expert. Le cas du spécialiste des facteurs humains de la sûreté nucléaire." Annecy, AIMS conference <http://www.strategie-aims.com/aims06/Actes06ss.html>
- [2]: Jean Lelièvre (1974), "L'analyse de sûreté et les études correspondantes", Annales des Mines, January, pp.55-61
- [3]: Entretien de François Cogné in Cyrille Foasso (2003), Histoire de la sûreté de l'énergie nucléaire civile en France (1945-2000). Technique d'ingénieur, processus d'expertise, question de société. PhD Thesis in Contemporary History, Université Lumière-Lyon II. p.253

RIA and LOCA safety criteria

IRSN/DSR/ST3C

1. Background

Major fuel evolutions were performed since the design of the French power reactors in the 1970-1980s:

- the loading of new fuel designs (e.g.: MOX fuel, doped fuel with Cr, Gadolinium incipients) that might behave differently from fuel pellet previously used,
- the evolution of the cladding material, for example the development of M5TM or advanced Zirlo,
- the fuel burn up increase up to values well above 39 GWd/t which was the discharge burnup value in France.

In 1998, the French Safety Authority (ASN) authorized the increase of the fuel burn-up up to 52 GWd/t for UO₂ fuel. The 52 GWd/t burn-up increase for MOX fuel with M5TM cladding is under progress.

At the present time, French Utilities are planning to reach values of burn-up up to 60 GWd/t for Mox fuel and 70-80 GWd/T for UO₂ fuel.

Among the design basis accidents the loss of core cooling (large break in the primary circuit) and the reactivity accident (control rod ejection) have an important impact on the design and on the safety demonstration. The safety analyses related to these events are governed by the criteria to be respected.

Thus, IRSN is considering the opportunity and necessity of re-examination of the requirements related to the advanced fuels acceptance criteria and the methodologies for safety analyses. This paper addresses the IRSN thoughts and planned work concerning the safety requirements for the reactivity initiated accident (RIA) and the loss-of-coolant accident (LOCA).

2. RIA requirements

Initially on French Nuclear Power plants, the safety demonstration for RIA was based upon the respect of a fuel enthalpy criterion value at core hot spot of 225 cal/g for fresh fuel and 200 cal/g for irradiated fuel. These values rely on SPERT tests on un-irradiated or at low burn-up fuel. These limits were intended to preclude fuel dispersal. By precluding fuel dispersal, coolable fuel geometry was assumed and steam explosion could not occur.

Mettre en évidence

During the 1980s and the 1990s, research programs revealed changes in both cladding and fuel pellet behaviour above 39GWd/t :

- The rate of cladding oxidation increases as a result of developing cracks in the initial oxide layer (caused by the corrosion during normal operation) and the occurrence of transient oxide spalling was demonstrated. This enhanced corrosion leads to hydrogen absorption which precipitates as zirconium hydrides. Cladding containing high concentration of hydride precipitates becomes more brittle than un-hydrided metal.
- The fuel pellet microstructure changes as large quantities of fission gases accumulate on grain boundaries. Prompt heating of fission gas bubble can explode the pellet micro-structure, mechanically load the cladding and drive fuel particles into the coolant.

These phenomena were suspected to alter the mechanical behaviour of fuel rods under RIA conditions and to enhance the risk of rod failure and of fuel dispersal in the coolant.

Experimental programs were launched to investigate fuel behaviour all around the world: NSSR in Japan, IGR in Kazakstan, BGR in Russia and CABRI in France. These tests displayed cladding failure with fuel dispersal at a rather low average fuel enthalpy than expected.

Consequently, French Safety Authority required French utility to justify high burn-up fuel behaviour in RIA conditions. EDF justifications for high burn-up fuel behaviour were first based on the experimental database focusing on tests without rupture, then on a temporary set of decoupling criteria so-called "empirical safety domain" to meet the ASN requirement related to the definition of one or several safety criteria based on physical parameters (analytical approach) in order to ensure fuel non dispersion and core coolability. Later on (in 2005), EDF proposed an analytical criterion based on Strain Energy Density versus the mean rod burn-up.

On its side, IRSN has been working since 2002 on a phenomenological approach (a methodology) to set up analytical RIA criteria. This process is based on the knowledge on the interpretation of Cabri, NSSR, Prometra results and will be completed by the end of 2008. IRSN considers appropriate to develop separate limits for coolability (dispersal of fuels) and cladding failure (considering different modes of rupture).

In any case, the EDF RIA criteria and the subsequent IRSN analysis will be discussed at the Safety Advisory Group in the coming years.

3. LOCA requirements

IRSN considers it's necessary to re-examine the requirements related to LOCA, for such subjects as pipe break size relevant to the safety demonstration, acceptance criteria and physical phenomena to be considered in the evaluation models.

3.1 Recent results of the R&D programs

Cladding behaviour

As it has been mentioned above, a significant cladding oxidation takes place during extended periods of normal operation and some of the liberated hydrogen is absorbed in the zirconium alloy cladding material. It is well known now that the oxide layer on the surface and the hydrogen in the metal affect the cladding's behaviour under LOCA conditions. Fuel behaviour under LOCA conditions should be addressed with regard to ballooning strains, flow area reduction, rupture conditions and cladding embrittlement. A comprehensive understanding of all involved phenomena and of their inter-related influences is not yet achieved and there are still pending questions. Research programs are still undergoing. Nevertheless recent program, especially those addressing secondary hydride occurrence and post-quench ductility, give important results that impair the existing criteria.

Fuel relocation

All the available tests performed with irradiated fuel rods experiencing LOCA conditions have shown an accumulation of fuel debris in the swollen region – called balloon – of the burst cladding which resulted from small fuel fragments slumping from upper locations and eventually fuel dispersal from rod. This process, called fuel relocation, is initiated at the cladding burst time and is driven by both gravity and pressure difference between the rod upper plenum and primary coolant. Recent Halden tests demonstrate the importance of this phenomenon.

3.2 Break size

Considering the break size, the principle of the Large Break LOCA preclusion has been accepted in France for the Evolutionary Project Reactor (EPR). Therefore, for EPR, the double-ended-break (200% of the full size of the primary cold leg) has not to be analyzed any more as a design basis accident nevertheless a best-estimate evaluation is still performed for ECCS and containment design. Justification bases for Large Break LOCA preclusion for EPR seem to differ significantly from those which led to the revision of the US 10CFR 50.46 proposed in SECY 05 0052. Whereas these ones constitute major changes in LOCA safety demonstration requirements, differences and similarities between American and French approaches will be presented to the French Advisory Committee. Furthermore, as break preclusion only concerns EPR power plants in France, the opportunity of relaxing requirements for large break LOCA safety demonstration for existing power plant will be investigated.

3.3 Physical phenomena to be taken into account in the safety demonstration

In the view of the future LOCA evaluation models assessment, IRSN has initiated work about physical phenomena occurring during a LOCA which are insufficiently considered or not considered at all in current evaluation models. For instance, IRSN will discuss fuel relocation and high pressure oxidation.

3.4 LOCA criteria

Concerning the LOCA criteria, with respect to cladding material and fuel pellet evolutions and burn-up increase, IRSN will re-examine these criteria bases.

The current regulatory criteria for LOCA, still in used in most countries, are derived from the ECCS acceptance criteria that were issued by USAEC in December 1973 and published in the 10.CFR 50. The criteria are stated as five requirements concerning the performance of the cooling system under the most severe LOCA conditions.

The two first requirements are related to cladding embrittlement. They were based on tests with unirradiated Zircaloy cladding material. The ductility tests themselves were of the ring-compression type and the results were evaluated at the saturation temperature during reflood of 135°C, which corresponds clearly to Large Break LOCA conditions. IRSN considers that recent results on cladding ductility should be taken into account in the frame of the criteria re-examination.

The third criterion addresses the maximum hydrogen generation.

The last two requirements are related to the core cooling which has to be maintained. IRSN deems that the assumptions related to flow area reduction and fuel relocation with regard to core cooling maintainability has to be considered in the frame of the criteria re-examination.

Besides, IRSN will pay special attention to the adequacy of future criteria for small and intermediate breaks. Coolability of balloons and requirements concerning post quench resistance should also be addressed. IRSN takes part to the international discussions on the LOCA criteria within the OECD working group.

4. Conclusion

Re-examination of the safety requirements in the perspectives of fuel design evolution and burn-up increase is planned today in France.

In particular, RIA and LOCA criteria for advanced fuel will be discussed in the coming years. LOCA phenomenology and best estimate methods to be used for safety assessment will be revisited by the end of 2010.

The IRSN experience feedback for the transport package design safety appraisals

Gilles SERT

IRSN/DSU

Executive summary

Initiated in 1996 by IRSN after a first review of the designs of the packages in service, the experience feedback process strongly contributes to assure a high level of safety in the radioactive material transportation activities.

Introduction

The activity of transportation of radioactive materials is in constant evolution; air transport of radio elements for medical use is growing rapidly as well as transport of instruments equipped with radioactive sources for inspections of buildings (controls of presence of lead in paintings) and in industry (non destructive examination of welding by gammagraphy, controls of density on building sites). Transports associated with the recycling of plutonium for the production of electricity by nuclear energy are now accomplished in routine. Globally, 900.000 packages are shipped each year in France; among them, approximately 100.000 packages belong to the category for which design approval is required.

To maintain a high level of safety for this activity by limiting the probability of occurrence, the severity and consequences of the incidents and accidents, strict rules are implemented by users under the control of the Safety Authority

According to the systematic approach of defence in depth, which is defined by the three principles of safety in design, of operational reliability and of effectiveness of emergency response, the robustness of the design of the package is of primary importance [1]. It is based on regulatory requirements relating to the functions of safety (containment of radioactivity, protection against radiation and prevention of the risks of criticality) that must be ensured by the package in conditions of transport as well as in accident conditions.

These rules and the way of applying them evolve with time. Indeed, on the one hand the regulation is re-examined periodically; on the other hand, the technical knowledge on the behaviour of the packages subject to the above mentioned conditions and the means of evaluation of this behaviour progress permanently.

The role of TSO IRSN in the design review process of the packages

As a national TSO of the Safety Authority, IRSN is in charge of independent expert assessments of the safety cases of the package design. Such assessments are applied to new designs, existing designs for design approval as well as for any design modification related to safety. IRSN also collects the data related to the transport accidents, incidents and operating deviations. Based on this extensive data collection, IRSN has developed specific approaches for assessing the safety cases as presented hereafter.

IRSN is also involved in the international cooperation including IAEA technical committees for the definition of the evolutions of the regulations.

Moreover, IRSN develops R&D actions and tests for basic data acquisition, overall test or codes qualification activities. These actions aim at identifying emerging issues or qualifying data used in the assessments. Part of these activities can be achieved in cooperation with applicants. In this case, the following conditions must be simultaneously met:

- the action aims at collecting basic data that are not be directly related to a safety case,
- the approval by IRSN of the conditions of the tests does not commit it to any further approval.

The package design review

Considering this evolution of the rules, knowledge and techniques, a process of periodic review of the design of the packages has been implemented. This has been facilitated by the current practice of renewal, every three to five years, of approvals of the package designs.

During these renewals, a re-assessment of the conformity of the package design to the regulation is carried out systematically; this assessment takes into account the evolution of knowledge on the behaviour of the packages in the different considered situations of transport; it also takes into account the evolutions of the regulation applicable to the considered design and lessons learned from the analysis of the incidents recorded in the course of use.

The re-examination of the package design safety reports made it possible to the IRSN to gradually constitute a data base of experience feedback known as "REX-TRANSPORT". Each time an evaluation highlights a defect or lack in justification, repetitive in nature, this defect is recorded in the base. The base, which thus grew rich gradually since 1996, is published annually or as soon as the number and the importance of the new defects justifies it.

The contents of this base are transmitted by the nuclear safety authority (ASN) to all applicants for package design approval. This information makes it possible to the applicants to level the justifications included in their safety reports, to even correct the package design, before applying for approval. This improvement step is likely to accelerate the instruction of these files by the authority and its technical support, IRSN.

The "REX-TRANSPORT" base is also used as a guide at the time of the periodic re-examination of the safety cases by IRSN. It helps in identifying, in a systematic way, the defects in the safety justifications provided in the safety cases. This approach is thus likely to reinforce confidence in the conformity of the package design to the applicable regulatory provisions.

Some examples of difficulties traced in the experience feedback which had important repercussions on the design of the packages.

Free drop onto the regulatory punch of a package specimen is in oblique position

Specific conditions of drop test considered as more penalizing than the current ones were identified; the risk of perforation of a package by a punch after a free drop test from a height of 1 m is strongly increased when the package is in oblique position compared to the horizontal top end of the punch. For certain packages, considering this new configuration of test simply resulted in supplementing the analysis of safety by a suitable argumentation; for others, it involved the need for reinforcing the thickness of the steel plates of the external protection; for others still, as for the packages designed to transport unirradiated fuel assemblies, it is the whole of the park of packagings which had to be replaced.



*Double-perforation of a prototype of package by the regulatory punch
(Courtesy of Framatome)*



*Position of drop with slap down
(Courtesy of CEA)*

Drop of a package with effect of slap-down

The free drop test of a package from a height of 9 m with a low angle with the horizontal can be until twice more penalizing than in the case of a drop of a perfectly horizontal package. Indeed, for such a drop concerning a slant shaped package, the first shock of an end of the specimen of package on the target produces a conversion of kinetic energy of translation into energy of rotation of which the effect is to increase the severity of the second shock on the other end. The analysis of this configuration of drop revealed weaknesses in the fixing devices of the shock protective covers for certain package designs. New concepts were then developed and successfully tested.

Capacity of thermal dissipation of tarpaulins and canopies

The use of systems protecting packages against the bad weather during transport is obligatory in France for the packages which are loaded underwater and which are likely to present a contamination on their external surfaces. These systems consist either in tarpaulins for the semi trailers or in canopies for the wagons. When the packages are loaded with irradiated fuel or high activity waste, they are likely to dissipate a high thermal power. In this case, the protection systems are especially conceived to allow the natural ventilation necessary to the good cooling of the packages. The IRSN pointed that all the numerous configurations of tarpaulins and canopies should be indexed and that the real capacities of thermal dissipation should be justified. This action led to a considerable reduction in the maximum allowed thermal powers in some of these systems.



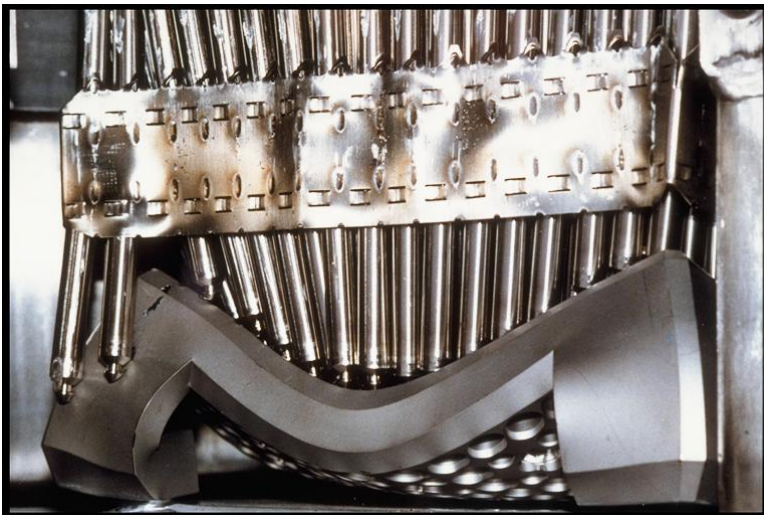
Wagon equipped with sliding canopies for the transport of irradiated fuels

Phenomena of radiolysis

The taking into account of the risks of production of flammable gases by phenomena of radiolysis during transport involved operational limitations on the activity of the contents being able to be transported like over the acceptable durations of preliminary storage and transport itself.

Modification of the geometry of the fissile contents

In accidental conditions, the transported radioactive material can be damaged with some change in geometry. A realistic evaluation of the behaviour of the fissile contents of the package is thus particularly important, insofar as a change of geometry is likely to call into question the prevention of the risks of criticality.



Example of deformation of a specimen of fuel assembly after the drop and fire tests (courtesy of TN international)

Performances of sealing

The mechanical resistance and sealing performance of the containment system of packages must be ensured until -40°C pursuant to the regulation. The leaktightness test criteria to be guaranteed by the measurements taken before shipment were re-examined; restrictions were established for the use of certain grades of elastomer in O-rings which do not preserve a sufficient sealing at this temperature.

The application of the base REX TRANSPORT is all the more effective as the number of the applicants concerned is limited and that the components of the various designs of package are often similar, which

reinforces the repetitive character of the experience feedback; it strongly contributes to guarantee the compliance with the rules applicable to package designs and to ensure an homogeneous level of safety.

Within the framework of the actions of renewal of the park of French packagings and certain foreign designs [2], this base showed all its interest. Indeed, the replacing new designs could profit, during their development, of the last techniques and knowledge available to justify the required performances. They now constitute a durable park of well optimized packagings.

Future prospects

Work is in hand within a European framework to work out a guide to assist in drafting the package design safety cases; integration, in this guide, of the experience feedback of the appraisals of the package design safety reports would make it possible to reach a new stage for the harmonization of the level of safety of transports accomplished in the European Union. In the long term, these results could also be integrated in the advisory guide published by the International Atomic Energy Agency; the required harmonization would then be still reinforced.

CONCLUSION

The specialized competency of TSO's is useful to detect inadequacies in the safety level, and then corrective actions may be implemented by users under the control of authorities.

References

[1] Revue Contrôle N°162, p 78-79, the safety of the transport of radioactive materials, January 2005.

[2] RAMTRANS journal, vol. 10, No 4, pp. 271-272, Situation report on compliance assurance in France, Nuclear Technology Publishing, 1999.

Addressing communications between Regulatory Body and TSO: *perceptions and problems*

I.P. Salati de Almeida

General Coordination of International Affairs

Nuclear Energy National Commission

Rio de Janeiro, RJ,

Brazil

ivsalati@cnen.gov.br

Abstract: The use of TSO assistance by the Regulatory Bodies is a way of facing the complexity of the technology and issues to be dealt with in the licensing and controlling process in the nuclear area. Although both TSO and Regulatory Body are well prepared and adjusted, the nature and environment of TSO work is rather different from the regulators'. Some of the TSO members act as a consultant, giving expert advice to the regulators in a specific subject, some are in charge of inspections and audits, others do the job together with the regulators. The way that a TSO member perceives the work to be done, however, often creates different perspectives for questions related to the licensing and controlling process. These perceptions are usually a source of problems between the two partners, regulators and TSO members. In this paper some of this kind of problems are raised and suggestions of how to deal with them are proposed to discussion.

1. Introduction

Regulatory bodies have to work within a strict conduct demarked by the law and by the standards in force. Often this is done by following the letter of the requirements more than a possible interpretation. This avoids that a personal point of view changes the results depending on who is in charge of the situation. Usually, regulators are less interested in finding a solution for the operator problem than in the consequences of the operator malfunctioning installation or practice. By the nature of their work, regulators are more linked to the means used by the operators to do their activities and less concerned to the results obtained by this work. This is expected, as they have to attain themselves to the routine, and regulation is made in order to avoid the necessity of examining and judging each case individually.

TSOs are usually institutions that work in the area of research and development. They are seeking to widen their knowledge and are also rewarded by the success they obtain in doing that. To them, problems are to be solved, not only diagnosed. Each situation is a prospective opportunity for challenge and research. By the nature of their work, they look for solutions and for the acceptance of their proposals.

These two different approaches are usually a significant source of problems in the relationship between the two sides. Regulators often complain that TSO members are not objective, that they use the data to publish papers, that they try to interfere in the way operators do their job, interfering in the first responsibility assigned to the operators related to the correct functioning of the activities and risk involved. By the other hand, TSO members complain that regulators are not willing to cope with the problem, that they just want to find a way to punish the operator or demonstrate their authority-based power. In most cases, these allegations are not true but people act as if they were. If the wrong perceptions that generate the conflict are not dealt with promptly, the misunderstandings tend to get worse.

2. Causes of conflicts: perceptions and communications

There are several possible situations that can cause misunderstandings and wrong perceptions between the role and work done by TSOs. Some of these causes are not unusual and suggestions can be given in order to cope with and to try to decrease the stress they cause to the relationship.

(a) *The TSO member acts as if he were an operator's consultant in the analysis.*

- Perception: the TSO member is perceived by the regulator as acting as an operator's consultant, trying to find a solution for the operator's problem and not clarifying what is the non-conformity point that he was called to analyze. This situation is particularly bad when it occurs during an inspection or audit in which the TSO member is part of the same team as the regulator.
- Reason: this kind of misunderstanding arises when the TSO members' job is not well expressed by the regulators. They are not completely aware of the boundaries of the result that is expected from their analysis, which are usually defined by the standards and regulations related to the analysis to be done. Their behavior in trying to solve problems can lead them to try to find a solution while it is expected that they point out the exact problem.
- Suggestion: a clear definition about how the job must be done, defining the role of the TSO member in the process.

(b) *TSO members try to invent new rules to apply to the analysis of a situation posed by the operator.*

- Perception: TSO members are perceived by the regulator as introducing new concepts out of the scope of the regulation.
- Reason: TSO members act in a more dynamic environment, usually in touch with the frontiers of knowledge, and are aware of new approaches to several problems. However, they often forget that regulation needs formal approval and acceptance given by an official body to be in force.
- Suggestion: the analysis and judgement have to be done based on the regulation in force. All the comments and findings must be referred to the specific point of the related standards. New approaches, even when accepted by the scientific community, must be formalized and become official by following the existing procedures for that.

(c) *TSO reports are sometimes of low value for decision makers because of the way they are written.*

- Perception: some assessment and inspections reports are written in a way that is very difficult for the regulator to make a decision based on it, because of a lack of order in the presentation of ideas, or lack of objectivity, or writing deficiencies.
- Reason: sometimes TSO members are not well prepared to write reports in the sense of the decision making process. Some of them are not well used to preparing the reports in a fluent language or in a way that a non-specialized person can interpret.
- Suggestion: standard models for reports can be prepared. Communication training or the use of an interface person inside of the TSO can help decreasing this problem.

(d) *The TSO work conflicts between research and regulatory analysis.*

- Perception: TSO member looking for data to produce a scientific paper, instead of focusing in the regulatory problem.
- Reason: in some cases, mainly during inspections and audits, some situations instigate the researcher inside the TSO member and he/she begins to query more than they need. This procedure can cause the lack of the main focus, decreasing the value of the inspection or audit.
- Suggestion: procedures to the inspection/audit must be established and practiced. The use of data obtained in regulatory inspections for scientific work or papers must be submitted to strict rules and approved by the regulator. The presentation of this paper, if approved, must be in such a way that the operator is not identified.

Other situations can be listed, but most of the cases of poor communication can be well addressed if a quality management system is established in the Regulatory Body and in the TSO. The role and responsibilities of the Regulatory Body and TSO must be well defined and understood by all the involved actors, including operators.

Every complex activity or work to be done out of the routine must be planned and formalized as a project plan, with objectives, goals, costs, responsibilities, indicators, etc. This can avoid misunderstandings about dates, costs and so on.

The TSO members must be prepared to give assistance to the Regulatory Body. A training program reinforcing the significance of their work to the whole process could improve the quality of the work.

3. Conclusion

TSOs can do a good job helping Regulatory Bodies, but the success of this operation is not obvious and it is not easily obtained. The existing conflicts and misperceptions must be dealt with in order to assure better communication and cooperation between TSO and the Regulatory Body.

Cooperation of Russian and EU Technical Support Organizations

Kuznetsov M.V., Kozlov V.I.V., Kapralov E.Yu.

(Federal State Unitary Enterprise VO “Safety”, Moscow, Russia)

Abstract. Since 1992, the fruitful collaboration of the Russian and Western-European technical support organizations (TSOs) is being continued due to the support of the European Commission. There are two main areas of activities. *The first one* is more of methodological assistance and enhancing RF TSOs capabilities to support Rostekhnadzor decision making process. Experience and knowledge acquired in this area projects increase RF TSOs capabilities regarding a wide spectrum of safety related issues assessment, in particular safety analyses, reactor vessel embrittlement, application of “leak before break” concept, severe accident and accident management, fire risk evaluation, etc. *The second area* is focused on licensing related assessments of EC financed on site assistance projects (modernisations). This area projects promote implementation in Russia a licensing process based on a technical dialogue between operator and regulator as well contributes to transfer of Western practice in assessment of NPPs modernization. The improvement of managerial, scientific and technical capabilities of RF TSO experts may be considered as noteworthy and practical result of the TSOs cooperation. The continuation of such modality of RF and EU TSOs cooperation will be a good basis to cope with present and future challenges faced by TSOs in enhancing nuclear safety.

1. Introduction

Since 2004 Rostekhnadzor is a Regulatory Body of Russia in terms of “Convention on Nuclear Safety” [1]. According to tasks entrusted to Rostekhnadzor it exercises among others the following functions [2]:

- develops drafts of legal and regulatory documents, approves and puts into effect federal standards and rules in the field of atomic energy;
- organizes safety reviews of nuclear installations, radiation sources and storage facilities with involvement of independent experts;
- organizes studies conducted by organizations under its jurisdiction to justify principles and criteria of nuclear and radiation safety, involves other research organizations, scientists and experts, including *foreign ones*, in conducting corresponding studies;
- organizes certification and verification of computer codes, development and maintaining of data banks by organizations under its jurisdiction for performing safety analysis of nuclear installations;
- conduct of activities on certification of equipment, products and technologies for nuclear installations, radiation sources and storage facilities.

These functions realization is designated to TSOs under Rostekhnadzor jurisdiction: Scientific and Engineering Center for Nuclear and Radiation Safety (SEC NRS) and Federal State Unitary Enterprise VO “Safety” (FSUE VO “Safety”). Organizational Chart is shown of Fig.1.

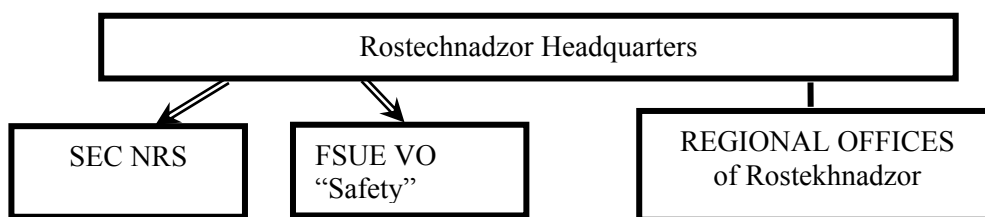


Fig.1. General Organizational Scheme of Rostekhnadzor

2. The start of cooperation

In 1992 the first contact with European Commission (EC) was established by Gosatomnadzor of Russia after defining by NUSAG G-24 on behalf of G-7 the urgent measures on safety improvement in the Central and Eastern Europe and CIS:

- Development of regulation regime
- Improvement of operational safety
- Short-term technical modernization based on safety assessment

EC Exploratory Mission was carried out in Moscow 18-23 October 1992, to provide more definite and sound basis of cooperation and assistance. The Exploratory Mission produced 42 exact recommendations [3], which formed background to EC funded projects in two directions:

- (1) Methodological assistance to Regulatory Body (RB) of Russia coordinated by the international group Regulatory Assistance Management Group (RAMG).
- (2) Support of Rostekhnadzor activity rendered in collaboration of the Russian and Western-European TSOs coordinated by the Technical Safety Organization Group (TSOG).

Hence, the collaboration of the Russian and Western-European TSOs has been facilitated by EC support in the frame of the second direction of activities.

The established cooperation was focused on the support in implementation of some of Rostekhnadzor functions (see section 1) with respect to the following aspects:

- (2).1. development of federal norms and rules on nuclear and radiation safety;
- (2).2. organization of and conducting the safety review of nuclear facilities to support Rostekhnadzor decision making process
- (2).3. organization and carrying out research to validate the criteria and principles of nuclear and radiation safety of specific rules and regulations and to estimate nuclear facility safety margins.

Thus, conventionally, the cooperation of EU and RF TSOs was organized in the area of methodological assistance and enhancing RF TSOs capabilities to support Rostekhnadzor decision making process, and in the area of more practical support dealing with concrete licensing related assessments of TACIS financed on site assistance projects in the Russian Federation (modernization).

3. Overview of cooperation results

3.1. Methodological assistance

The transfer of Accident Analyses Codes (e.g. ATHLET, CATHARE, COCOSYS) and strength related Codes (e.g. WinLECK), as well as RF TSOs experts training in Western European countries have been provided. This activity is still undergoing more particularly on analysis of different accident scenarios such as ATWS, accidents at low power and shutdown states, accidents leading to reactor pressure vessel thermal shock. More attention is being paid to selection of representative scenarios to be analyzed. The reasonability of coupled 3D neutronics and thermal hydraulic codes application for some of accident scenarios is under consideration.

Another group of projects has been devoted to transferring EU TSOs methodology and practices regarding a wide spectrum of safety related issues, in particular:

- safety analyses and assessment, which can be used while making a decision concerning service life extension of the “old” NPPs units;
- reactor vessel embrittlement analysis, including consideration of effects of annealing on reactor vessel strength recovery and expediency of annealing in case of service life exhausting as well consideration of measures to decrease neutron flux on reactor vessel;
- application of “leak before break” concept for NPP’s primary circuit pipelines;
- severe accident and accident management, with common development of technique for elaboration of the list of Beyond Design Basis Accidents (BDBAs), this technique serves as the basis for development of a list of representative scenarios of beyond design basis accidents, which are to be taken into account in the development of measures and guidelines on management of such accidents;
- fire risk evaluation with respect to analysis of effects of fire and its consequences on the reactor installation safe shut down;
- improvements of operational events classification in respect to their impact on safety, assessment of NPP unit operation safety state using the results of operational events classification and safety performance indicators analysis; etc.

Experience and knowledge acquired in the process of these projects implementation promote improvement of scientific and technical capabilities of RF TSO experts.

3.2. Support in licensing related assessments of NPPs modernization

These projects promote the implementation in Russia a licensing process based on a technical dialogue between operator and regulator through carrying out license follow-up of industrial projects aimed at NPP safety improvement. Such type of Projects was named "2+2 approach" projects. The co-called "2+2 approach" can be demonstrated by a scheme presented in Fig.2:

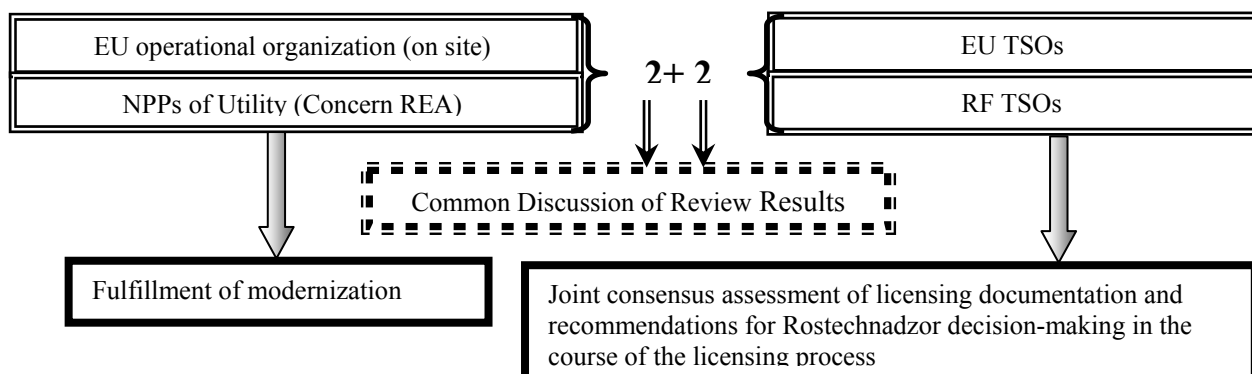


Fig.2. Scheme of "2+2 approach" projects

The transfer of Western practice in assessment of NPPs modernization during projects implementation contributes to enhancing RF TSOs capabilities to assess different modernizations (see Table 1). On another hand, the implementation of these projects in a number of cases has demonstrated similarity of RF-EU regulations and approaches to assessment. Thus, in a certain sense, the dialogue between EU and RF TSOs experts was a kind of Russian and Western requirements and approaches *harmonization*.

Table 1.

<i>Modernization</i>	<i>Reactor</i>	<i>NPP</i>
Replacement of feed-water control valves	VVER-1000	Kalinin, Balakovo
Replacement of pilot valves for pressurizer safety valves	VVER-1000	Kalinin, Balakovo
Replacement of safety valves on SG	VVER-440, 1000	Kola, Balakovo
Installation of thermal H ₂ re-combiner in containment	VVER-1000	Kalinin
Upgrading of plant computerized information system (CIS)	VVER-1000	Kalinin
Replacement of safety related batteries	VVER-1000	Balakovo
Installation of filtration equipment for inlet pumps in emergency core cooling system	VVER-1000	Balakovo
Steam generator level control system	VVER-1000	Balakovo
LNPP Radwaste Solidification Facility	RBMK-1000	LNPP, Kola
Instrumentation and Control improvement	VVER-1000	Kalinin

3.3. Results – TSO situation

Having summarized the examples of activities mentioned above it is easy to see, that they may be considered as noteworthy and practical result of the TSOs cooperation, which at the latest stages of program realization developed into the fruitful collaboration of the Russian and Western-European experts.

To assess the achievements of the whole program in particular against recommendations of Exploratory Mission, measurable/verifiable indicators have been developed. Some of them, directly connected with TSOs activities, are presented in Table 2.

Table 2

<i>Nº</i>	<i>Name of indicator</i>	<i>Progress</i>
Group 2. Establishment and sequential updating of licensing process and activities		
2.3	Technical capability and resources are sufficient to carry out reviews and assessments independently of the Utility, designers, architect engineers	very much improved (VMI)
2.4	Safety assessments of licensees facilities are carried out	VMI

- | | | |
|-----|---|-----|
| 2.5 | Regulatory body's TSO have the necessary access to the information which is necessary for safety related investigation (data base for each NPP) | VMI |
| 2.6 | The TSOs' research means (analytical and experimental) are maintained up-to-date | VMI |
| 2.7 | Existence of the interaction between the applicant/licensee and regulatory body to discuss the review findings and address the solution of safety issues. | VMI |

The TSO situation was very much improved. Therefore "strength margins" of their capabilities to fulfill designated functions are sufficient.

4. Further needs - to withstand challenges

However, data on measurable/verifiable indicators analyses revealed some still existing gaps, for example:

Group 2. indicator № 2.1.

The requirements for Safety evaluation Report (Standard Review Plan) are still not exist in Russia.

indicators № 2.3. -2.6.

TSOs still need increasing of it's capabilities for providing scientific and expert support to Rostekhnadzor, e.g. the methodology on uncertainties assessment and analysis is not available.

Group 3. indicators № 3.2, 3.3.

The regulatory document (RD) on back fitting of operation experience is not developed.

Group 5. indicator № 5.2.

The regulatory body aims at adaptation of risk informed regulation.

Group 7. indicator № 7.2.

The regulatory document with requirements to the Accident Management Procedures at the NPP, especially with severe accidents management, is not developed.

These gaps may be recognized as needs for further activities and suggestions of themes for further cooperation as well a good basis for future overcoming of challenges.

The theme of challenges was raised e.g. at International Conference on "Topical Issues in Nuclear Installation Safety: *Continuous Improvement of Nuclear Safety in a Changing World*" organized by IAEA in Beijing, China 18–22 October 2004. The Conference discussions and presentations demonstrated rather evidently, that challenges result from *a Changing World* and it is very clear, that

TSO challenges $\approx$ Regulatory Body challenges

It is possible to categorize Challenges (roughly) as follows:

International Challenges (I)	Technical Challenges (T)
National Challenges (N)	Social Challenges (S)

As example of combined N+T+S Challenge in Russia may be considered provisions of 'Fundamentals of the state policy in the field of nuclear and radiation safety Russian Federation until 2010 and beyond this period' formulated by President, which were published on December 4, 2003 (Pr-2196) [4], e.g. "to increase in effectiveness of licensing activities and safety expert reviews" and "improvement of effectiveness of international cooperation in the field of nuclear and radiation safety".

Examples of combined I+T Challenges are Multinational Design Approval Program for New NPPs [5] and IAEA initiative "Development of a Scheme for safety certification of evolutionary and innovative reactors" [6]. These are challenge to national regulations because for "approval" the NRC technical review portion of the U.S. Design Certification Process must be used and for "certification" - IAEA Safety Standards. The necessity of national regulations harmonization with US CFR and IAEA NUSS is evident. This is also applied to global challenge – *harmonization of requirements*.

The lack of young specialists in the field of nuclear science and technique i.e. "ageing" of TSOs personnel is a kind of N+S Challenge.

The tremendous Program for Nuclear Energy Development is in place in RF, covering the next years up to 2015 [7]. TSO's role should increase in these conditions. The provision of support to Rostekhnadzor will involve actively TSOs and be concentrated on the following important directions:

- to protect against loosing of competence and knowledge and ensure rejuvenation of staff;

- refreshment training of staff, including more close cooperation with industrial side scientific and design organization and thus increasing ability to assess safety justifications in the main areas of the Programme :
 - innovative reactors design,
 - prolongation of “old” units operation,
 - accounting and control of nuclear material and radwaste treatment,
 - improvement of physical protection systems and means at nuclear power facilities, enhancement of their stability to sabotage and terrorist activities,
 - decommissioning.

With this respect, the continuation of the established modality of RF and EU TSOs cooperation and exchange of knowledge, without any doubts, will serve a good basis to cope with present and future challenges faced by TSOs in enhancing nuclear safety.

REFERENCES

- [1] Decree of the Government of the Russian Federation № 401 dated 30.07.2004 “On Federal Environmental, Industrial and Nuclear Supervision Service of Russia”.
- [2] Russian Federation National report on the fulfillment of commitments resulting from the Convention on Nuclear Safety, 2004.
- [3] Report on Exploratory Mission to the Russian Federation to Analyse the Nuclear Regulatory System. Moscow, October 18 – 23, 1992.
- [4] Fundamentals of the state policy in the field of nuclear and radiation safety of the Russian Federation until 2010 and beyond this period Pr-2196, 4. December 2003.
- [5] Multinational Design Approval Program for New Nuclear Power Plants. Presented by James Linville at Technical Meeting on Development of a scheme for safety certification of design of evolutionary and innovative reactors. IAEA, Vienna 21-25 November.
- [6] Report on Technical Meeting on “Development of a Scheme for safety certification of evolutionary and innovative reactors”. IAEA Headquarters, Vienna, Austria. 21-25 November 2005.
- [7] Federal target-oriented program “Development of nuclear power-industrial complex of Russia for the period of 2007-2010 and on further perspective up to 2015 ” adopted by the Russian Federation Government(al) Regulation of 6 October 2006 № 605.

Technical and scientific support to nuclear regulatory authority in Montenegro *Present situation and outlooks for the future*

S. Jovanovic

University of Montenegro,
Faculty of Sciences, Department of Physics,
P.O.Box 211, Cetinjski put bb,
MNE-81000 Podgorica, Montenegro, and

Centre for Eco-Toxicological Research of Montenegro,
Department of Radiation Protection and Monitoring,
P.O.Box 374, Put Radomira Ivanovica 2,
MNE-81000 Podgorica, Montenegro

Abstract. Nuclear regulatory competences in the Republic of Montenegro are shared between the ministries of health and of the environment. Following the independence of the country by mid 2006, Radiation Protection Commission (RPC) is established within the Ministry of Health, so as to match the regulatory role for the sources used in medicine. A similar step is expected to be made soon within the Ministry of the Environment, too. The two commissions will likely and logically merge into one, representing an interim regulatory authority to be functioning until a full capacity and effectively independent regulatory body is established by new nuclear law. Promulgation of the latter is expected to take part in the course of 2007. Let us mention here that the law in force is one from 1996 – quite obsolete and not taking into consideration the Basic Safety Standards (IAEA, 1996) and subsequent IAEA and EU documents in the field. Montenegro is a small, non-nuclear country (no nuclear installations or fuel cycle segments), the use of radiation sources being limited mostly to medical and industrial applications. Technical support to regulatory functions, in whatever basic form these were effectuated up to now, was/is given by the Centre for Eco-Toxicological Research of Montenegro (CETI), Department of Radiation Protection and Monitoring, in Podgorica. As to scientific support, it is fundamentally to be found at the University of Montenegro, Faculty of Sciences (FS), Department of Physics. While CETI is relatively well equipped, running quite a modern nuclear spectrometry laboratory (alpha, beta and gamma spectrometry, radon measurements) and having a decent dosimetry unit (TLD, field and workplace monitoring), FS is practically limited to sporadic theoretical studies, with very poor laboratory capabilities. Environmental radioactivity monitoring is performed by CETI, following the programme defined by the government. Licensing and inspections are the two regulatory functions still in rudimentary form, being the first to be dealt with by the newly formed RPC. Not necessary to say, funding is the weakest point in the story and is likely to remain the limiting factor of the regulatory control of radiation sources in Montenegro. The new law itself will possibly improve the situation, but for sure will not solve all the problems in this respect.

1. Introduction

Following major constitutional changes in February 2003, which redefined Serbia and Montenegro as *de facto* a loose confederation of two constituent states, and their subsequent separation/independence by June 2006, all radiation/nuclear related state competences went separately into the portfolios of the Republic of Serbia and of the Republic of Montenegro. Having no previous experience with effectuating regulatory functions in this field, Montenegro was faced with the task of establishing the regulatory infrastructure from the scratch.

Facing the above political changes and being aware of legal and institutional vacuum which was clearly going to be subsequently created in regulatory functions, a group of professionals in the field initiated - already in 2002 - formation of the adequate framework for the radiation protection and for the security and safety of radiation sources. Connections were sought through official channels with the IAEA and Montenegro was soon admitted to Regional technical cooperation “model” project RER/9/080, which aimed at strengthening safety, regulatory control included, of radiation sources, waste and transport in the Mediterranean region.

With the help of IAEA experts, an improvement was soon visible, especially in education and training of the staff to be involved in regulatory activities. Also, a draft law on radiation protection, stipulating i.a. the establishment of an effectively independent regulatory authority was written and submitted to relevant ministries (of health and of the environment) so as to be further processed (government, assembly) [1].

It was expected that the process of promulgating the law and establishing the regulatory authority was going to be relatively smooth and fast. However, it turned out that administrative inertia, together with major political changes mentioned above, retarded the procedure so that it is not completed yet (first quarter 2007).

At present the law is still being reviewed. Several versions were produced to reflect changes in the understanding (and willingness) of how the regulatory competences will be effectuated. The understanding of the regulatory body independence was (and still is) the major stumbling block, turning the draft back again and again.

Meanwhile, in the Ministry of Health the Radiation Protection Commission (RPC) was formed by the decision of the Minister by June 2006. RPC is entrusted with regulatory control of radiation sources in medicine, within the existing legal framework (Radiation Protection Law from 1996 [3] and subsequent regulations). A similar step is expected to be made soon within the Ministry of the Environment, too. The two commissions will likely and logically merge into one, representing an interim regulatory authority to be functioning until a full capacity and effectively independent regulatory body is established by new nuclear law.

2. Technical support – Centre for Eco-toxicological Research

Montenegro is a small developing country (population 670.000). It is also a non-nuclear country (i.e. no NPP's, no fuel cycle elements), the application of radiation sources being limited mostly to medicine (some 100 large X ray machines, 500 dental ones, few CTs, few bone densitometers, one 6 MeV linear accelerator for radiotherapy, an angiography department and a newly re-established nuclear medicine department), and to industry (mining, steel and aluminum smelting and processing). Therefore, also the regulatory functions, including technical and scientific support elements, should be adequately tailored and commensurate.

It should be mentioned hereby that Montenegro is, by the first article of its constitution, defined as an “ecological country”. This means that, in principle, all major decisions and steps to be undertaken in the country should be viewed from environmental protection/preservation standpoint. This implies radioecology being quite an important part of regulatory concern.

An example of the above is recent construction of low and intermediate radioactive waste storage in Podgorica, financed by the Government of Montenegro. Namely, it turned out already after constitutional changes in 2003 that Montenegro was not allowed anymore to store its radioactive waste in the storage it used up to then (in “Vinca” institute near Belgrade, Serbia). Whatever small quantities produced in the country (e.g. disused industrial sources, old radioactive lightning rods, smoke detectors), it needed to be stored somewhere. This led the Ministry of the Environment to commencing the construction. It is now finished, while the equipment (for protection, waste manipulation, radiation measurements and monitoring and for security) is expected from a national TC project with IAEA in 2007. Storage construction was among the largest single investments into environmental protection infrastructure in Montenegro in the past few years.

Centre for Eco-toxicological Research of Montenegro (CETI) was established in 1996 as a governmental institution to deal with environmental pollution and monitoring issues in the country. Some 80 people are employed, most of them with university degree. Within CETI, Department of Radiation Protection and Monitoring deals with radioactivity measurements and monitoring. The department is well equipped with pretty modern nuclear spectrometry systems (gamma- in particular), but has no possibilities for radiochemistry practice. Radon laboratory is also a decent one, as well as dosimetry lab (TLD, personal, field and workplace dose monitoring). There are 5 physicists, 1 chemist, 1 technologist and 2 technicians. The staff is well trained, but some more formal education (specialization) would be desirable. In this sense, participation at IAEA technical cooperation projects offers good opportunities.

Although established and owned by the government, CETI gradually became a fully market oriented enterprise. Analytical, monitoring, consulting and training services are offered to customers not only in Montenegro, but in the neighboring countries as well. Department for Radiation Protection and Monitoring contributes significantly to this. Among the services of the department are gamma-spectrometry analyses, radon measurements, import/export radiological control of food, feed, construction materials and consumers' goods.

On yearly basis, the department is performing the monitoring programme of the radioactivity in the environment in Montenegro. The department has also successfully completed the campaign of cape Area decontamination of depleted uranium in 2002 (after war conflict in 1999) with highest professional standards [3,4].

Management of the radioactive waste storage is contractually entrusted to CETI by the Ministry of the Environment.

Surviving on the tiny local market of sophisticated services and renewing the costly equipment from its own funds are among the major current concerns for the firm management.

3. Scientific support – University of Montenegro

By the late 70's a well operational nuclear spectrometry laboratory was established at the Faculty of Sciences, Department of Physics, University of Montenegro in Podgorica. For many years the laboratory served as the only one of the kind in Montenegro. It performed radiological analyses of various types of samples – food, feed, soil, waters, construction materials, consumers' goods, has dealt with post-Chernobyl measurements and monitoring, etc. It was also the educational focal point for the students of physics and enabled intensive national (in Yugoslavia) and international scientific cooperation with analogue ones around Europe.

Nowadays, following the years of economic collapse in the 90's, the lab is in poor shape. None of the three functions (scientific, educational, technical support) work anymore. Its perspectives are uncertain, the expensive equipment being not easy to replace, while new, young and ambitious staff is not at sight neither.

4. Conclusions

Establishing the adequate regulatory framework for the control of radiation sources, including the commensurate technical and scientific support services, seems to be not an easy task for a small and newly independent country, Montenegro. Historical, political, organizational and financial factors are overlapping. However, continuing the use of radiation sources without proper, internationally adopted safety and security standards, especially in medicine, is unacceptable. In this sense, the assistance of international bodies, in particular those of the EU and IAEA are of the utmost importance. Positive steps are being made recently, like is the construction of radioactive waste storage in Podgorica and establishment of Radiation Protection Commission within the Ministry of Health.

REFERENCES

- [1] MINISTRY OF THE ENVIRONMENT OF MONTENEGRO, TASK GROUP, Radiation Protection Law of the Republic of Montenegro, draft, Podgorica (2003-2005)
- [2] Radiation Protection Law of the Federal Republic of Yugoslavia, Official Gazzette of the FRY, No. 46/96 (1996)
- [3] Depleted Uranium in Serbia and Montenegro - Post-Conflict Environmental Assessment, UNEP, ISBN 92-807-2146-1, Geneva, Switzerland, 2002.
- [4] Decontamination from Depleted Uranium of the Cape Arza, Centre for Eco-toxicol. Research of Montenegro, Podgorica, Serbia and Montenegro, Report, 2002.

Promoting Safety Culture in Radiation Industry through Radiation Audit**Norih M.A.**

Quality Assurance
Secondary Standard Dosimetry Laboratory
Malaysian Nuclear Agency (Nuclear Malaysia)
Bangi, 43000 KAJANG
Selangor
MALAYSIA

Abstract

This paper illustrates the Malaysian experience in implementing and promoting effective radiation safety program. Current management practice demands that an organization inculcate culture of safety in preventing radiation hazard. The aforementioned objectives of radiation protection can only be met when it is implemented and evaluated continuously. Commitment from the workforce to treat safety as a priority and the ability to turn a requirement into a practical language is also important to implement radiation safety policy efficiently. Maintaining and improving safety culture is a continuous process. There is a need to establish a program to measure, review and audit health and safety performance against predetermined standards. This program is known as radiation safety audit and is able to reveal where and when action is needed to make improvements to the systems of controls. A structured and proper radiation self-auditing system is seen as the sole requirement to meet the current and future needs in sustainability of radiation safety. As a result safety culture, which has been a vital element on safety in many industries can be improved and promote changes, leading to good safety performance and excellence.

1. Introduction

The radiation industry brings substantial benefits to society with regard to the assessment of the integrity of industrial installations. As long as the authorities and standards prescribe activities, it will remain a justified practice. Nevertheless, the uses of radiation in industry can be regarded as challenges in the present day. Events and incidents, whether related to industrial safety, radiological or nuclear safety are seen not as part of normal working life, but as exceptional and unacceptable occurrences that are avoidable. In some cases, the associated environmental damage is notable and restoration is financially costly. It is therefore, for this reason that all these activities require prior authorization from the relevant authorities. The introduction of the Atomic Energy Licensing Act, followed by the establishment of the Atomic Energy Licensing Board (AELB) in 1984 are serious initiatives taken by the Malaysian Government to regulate, safeguard and monitor the ionizing radiation activities in Malaysia. In addition, AELB is to complement the functions of Malaysian Nuclear Agency (formerly known as Malaysian Institute for Nuclear Technology Research (MINT)) in promoting the peaceful use of nuclear technology. Since radiation issues are of national interest, the government has taken proactive approaches by formulating radiation safety strategies, whereby due consideration is given to the application of nuclear technology in various economic sectors without compromising on radiation safety standard. Up to 2007, there are about 1,700 different workplaces with about 14,000 radiation workers involved with ionising radiation in the country, from 3 categories of job activities, namely medical, industrial and non-destructive testing (NDT).

Topical Issue 1: Role of TSOs in enhancing nuclear and radiation safety

Many of the challenges in radiation industry have the potential to influence the safety culture in the workplace. Radiation safety is based on a whole set of regulations and standards, design solutions, operating instructions, safety culture, training, the work of regulatory bodies and other factors, all of which contribute to the control of the occupational exposures and prevention of the release of radioactive materials into the environment. While engineering safeguards and formal management system to control risks are essential, it is equally important to get commitment from the workforce to treat safety as a priority and to turn the concept into a practical (everyday) language. Economic and other business pressure have the potential to distract the managers in an organization from their visible commitment to safety culture. This reduction in visible support for safety culture coupled with a workplace, who may be demoralized by perceived job insecurity associated with business pressures, can have a detrimental impact on the motivation of workers to work safely and maintain their alertness..

Current management practice demands that organization inculcate culture of safety to protect the workers, public and the environment from the hazards of radiation. An organization can only meet the aforementioned objectives of radiation protection if it has proper organizational structure, statement of radiation safety policy, defined responsibilities for employer/employees, documented procedures and work instructions for processes, monitoring/surveillance and adequate resources to implement radiation safety policy. Maintaining and improving safety culture requires continuous process. There is a need to establish a program to measure, review and audit health and safety performance against predetermined standards. This program is known as radiation safety audit and is able to reveal where and when action is needed to make improvements to the systems of controls. Proper safety audit will be help to identify the non-compliance of safety culture as well as the deviation of management, individual and policy level commitment, the audit and review of radiation protection program and activities should be preceded. As a result safety culture of the facility can be improved. Personnel attitudes and habits are generally intangible but the deviations of personnel attitudes and habits through the safety culture also can be tangible through safety audit. Therefore, the safety culture components could be developed through the radiation safety audit.

2. Radiation Safety Audit

Radiation safety audits are an in-house means of ensuring radiation safety compliance at all times. It is a systematic and independent examination to determine whether radiation safety activities and related result comply with planned arrangement and whether these arrangements are implemented. An internal radiation safety audit would normally be carried out when the facility first commences operation, and thereafter at least annually. In addition, a radiation safety audit would be performed whenever new irradiating apparatus or radioactive sources are installed or received, and after a major service of radiation equipment. The role of audit in radiation safety program is illustrated in Figure 1.

Topical Issue 1: Role of TSOs in enhancing nuclear and radiation safety

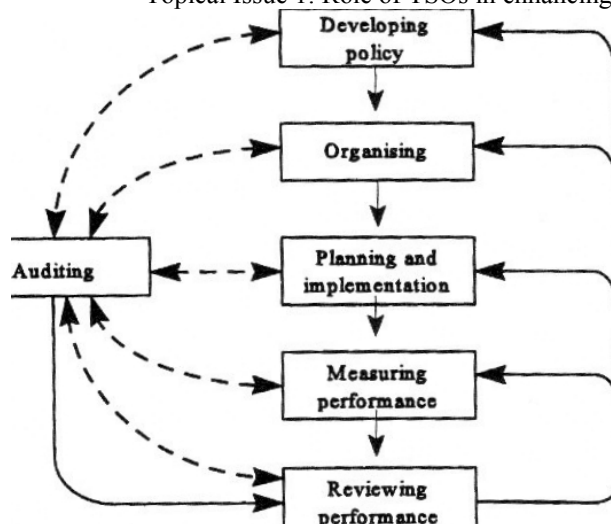


FIG.1. Role of audit in successful radiation safety program

Audits are typically performed to evaluate compliance with local, state and federal regulations and considered as a key to monitor radiation-wide safety. Audits are one route, by which operational problems are detected (i.e. documented practices does not reflect actual practice). This is an inherent part to ensure the safety system is working properly. In lieu of documented procedures, auditors will have to audit people by asking for a demonstration of effective control over processes and systems. Management will have to provide evidence of their commitment and involvement. An auditor's skill in obtaining objective evidence through questioning techniques will be of primary importance. This includes looking for forms, records, charts and minutes of meetings to support compliance to the requirements of the standard. It serves as a guide to correct the unnoticeable problems and also serves a great boost of confidence to attain a high degree of accuracy in the safety system. Emphasis on correcting the root cause of problems enhances the productivity and efficiency leading to cost reduction.

The principal licensee has overall responsibility for the radiation safety audit. In practice it may be convenient to assign this duty to an appropriate individual at each facility who should systematically work through the requirements for radiation safety and verify compliance. Proper audit required steps as shown in Figure 2, which includes:

- (a) Pre –audit: Preparation of audit plan, checklist and audit team
- (b) Audit Performance: To collect objective evidences
- (c) Post-Audit: Verifying corrective action and final reporting.

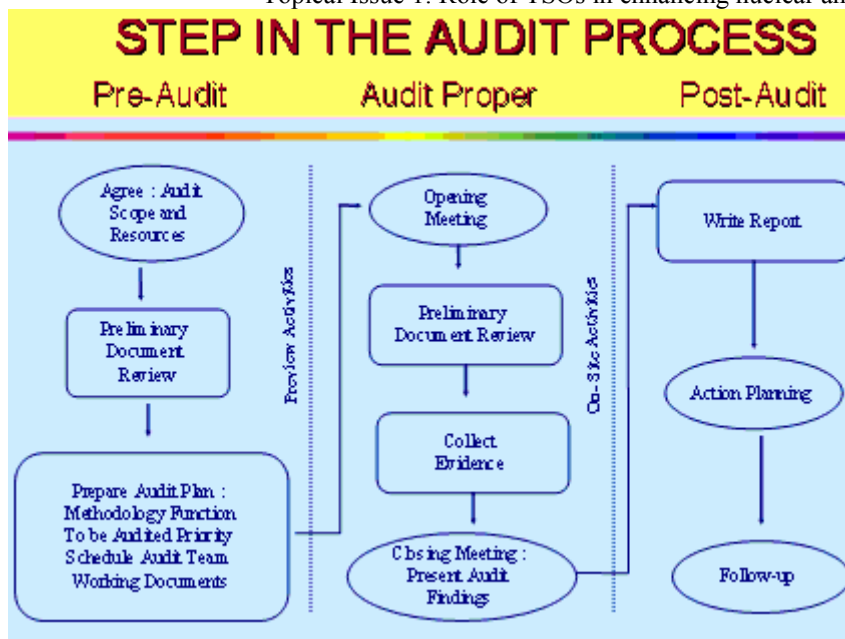


FIG.2. Step in the radiation safety audit process

An obvious task to start is to have a proper radiation safety plan and its records. The radiation safety plan may incorporate existing documents, but it must have a contents directory that identifies any incorporated documents (location, version number, etc) so that the whole plan may be readily accessed. Adherence to the radiation safety plan should help ensure that the radiation doses to users are below the prescribed limits and, in addition, as low as reasonably achievable (ALARA). Also it will ensure that the number of persons exposed to radiation and the likelihood of unexpected exposures are minimized.

The easiest way to do this is to have a checklist, which is developed, based on the requirements derived from the Basic Safety Standards (BSS) for Protection against ionising radiation and for the safety of radiation sources, issued by the International Atomic Energy Agency (IAEA), as Safety Series 115. The standards specify requirements for notification of the regulatory authority of the intention to undertake a practice, and for authorization, either by registration or by licensing.

The records of irradiating apparatus and radioactive materials need to be checked by physically sighting these, and labelling and warning signs checked. Authorizations, written local rules, procedures and other documentation in the radiation safety plan must be reviewed. In many cases measurements of dose rates near irradiating apparatus or radioactive sources will need to be made and recorded. Sealed sources will need to be wipe-tested at appropriate frequencies.

Another aspect that merit special mention is reporting of non-conformance/non-compliance (NCR). There are various ways of reporting non-compliance but the most common is by completing a specially prepared form. Anything found during the audit that is not satisfactory must be noted with details of remedial actions. The audit documents must be completed, signed and filed in the radiation safety plan so that when a regulator does a compliance monitoring inspection there is evidence that the radiation safety audits have been performed and meet their purpose of ensuring on-going compliance. Corrective actions identified need to be performed as soon as practicable and a record made in the radiation safety plan.

The audit process serves as an effective mechanism to recommend and track corrective actions. Written audits are provided to the designated recipient, along with suggestions for mitigation of issues

Topical Issue 1: Role of TSOs in enhancing nuclear and radiation safety

and steps for reporting the corrective actions taken or plan for correction. Audits indicate the areas for improvement, which is a key to providing effectiveness in the radiation safety and its can be described as continuous and continual. This was followed by focusing on finding and fixing problems, indicating that the system is being used positively, and lastly, data analysis for further improvement of the radiation safety program.

3. Scenario of Radiation Safety in Malaysia

Implementation of Act 304,1984 is known to be the first step in the harmonization of the Malaysian National Radiation Protection System. The effectiveness of the radiation program implemented in the workplace is based on the trend of the occupational dose distribution. The percentage of radiation workers exceeding 50 mSv, which is less than 1%, and was maintained for over a 15-year period, indicated proper planning and implementation of radiation safety program to achieve ALARA doses in the country. It also demonstrates great efforts of the regulating body, AELB and Nuclear Malaysia to promote radiation safety awareness among radiation workers through a good radiation protection program at the workplace.

Training program offered by Nuclear Malaysia is seen as one of the catalyst for the proper use and implementation of radiation safety, as stipulated by the regulation. Rapid development in the application of ionising radiation has created a new opportunity in training needs. The training module is designed to respond to the needs arising from the legislative requirements, in line with the enforcement of the Act 304. Hence, those who deal with ionising radiation, regardless of their economic activities, are required to attend the recognised training. A training program is designed or tailored to meet the needs of customers. In this regards, Nuclear Malaysia has provided all these opportunities to cater for the changing needs of customers. With suitable training approaches, dedicated trainers, state of the art training facilities, the training has attracted numerous customers from various industries and institutions of higher learning both local and abroad. To improve safety performance in an organisation, those involved in radiation activities are required to undergo continuous professional education (CPE) to refresh and enhance their knowledge, and improve skills in radiation related areas.

In industrial and research facilities, the average occupational doses are generally quite acceptable. The decreases in average doses may not be sustainable in the face of changes in work requirements. In specific work that involves high routine exposure, safety relies largely on procedures and human performance. Analyses of accidents have identified the major cause as failure to follow procedures, especially with regards to the use of proper dosimeter and personal protective equipment. Findings from the surveys on several facilities using ionizing radiation showed that internal safety audit is the most common aspect ignored in almost all facilities. This does not indicate a healthy approach to the safety culture characteristic. With widening of the scope of application this may lead towards unwanted events relating to radiation technology. Similar comments are also relevant to the use of gauge sources in general industry, and the wider issue of source security is becoming a significant international concern with lost sources becoming a hazard to working groups who are not normally exposed to radiation.

4. Promoting Radiation Safety Audit

The effectiveness of the safety program can be improved if radiation safety audit is performed on the system. Through self-audit, the performance of the radiation safety can be monitored to check its effectiveness and to achieve stakeholders' satisfaction. The data and findings from the audit can be used as a basis for decision within the organization through adequate analysis. It is useful to describe

Topical Issue 1: Role of TSOs in enhancing nuclear and radiation safety

improvement or deterioration in the system and may give chance for early action to prevent any non-conformity in the system

Nuclear Malaysia has pioneered and conducts training for internal auditing of the radiation safety in the past three years for the public and private sectors. The radiation safety audit course is developed with modules describing the content of the audit trainings and the performance of internal audit in organization dealing with nuclear technology. Through this course, radiation protection officers will be able to conduct self-audit in his or her own premise. The main aim of the audit is to:

- (a) Maintain facilities and equipment in a safe operating condition.
- (b) Provide a safe working environment for all employees and assess the level of emergency readiness.
- (c) Ensure that all procedures and activities are conducted in a safe and prudent manner.
- (d) Ensure adherence to the content of the safety manual.

AELB is presently encouraging organizations dealing with nuclear technology to slowly and voluntarily adopt the Radiation Safety Management System, in line with requirement of the Occupational Safety and Health (Safety & Health Committee) Regulation 1996. The OSH Regulations specifically stipulates the need to take into consideration on safety audit to protect the safety of the employees. In realising this need, Nuclear Malaysia has initiated a course on Integrated Radiation Safety Management, IRSMS, which is aimed to highlight the integration IAEA and AELB standard and requirement into the Occupational Safety and Health (OSH) management. Through this integration, it is able to manage a variety of hazards on environmental, safety and health and by promoting safe behaviour at all levels of workers.

As a structured system, IRSMS is seen to be a competitive and sustainable product. The course is aimed to provide the basis of integration into OSH management to ensure adequate protection of workers, the public and the environment and encourage licensee to manage radiation safety based on performance, and not on compliance culture, with the final objective of professing a safety culture through self regulation. There is a significant improvement observed in the IRSMS as compared to the current Radiation Protection Program. This will certainly benefit an organization with ultimate goals of continuously striving for a healthy, accident-free and environmentally sound workplace and community, while providing the technical support needed to meet the national mission.

5. Conclusion

In Malaysia, the implementation of radiation and waste safety training is to enhance the safety performance in an organization that leads to the development of a safety culture, in line with the spirit of national atomic regulation. Radiation safety audit will help to identify the deviations of radiation protection program and to take necessary action to fulfill the regulatory requirements. Radiation safety audit is seen as a continuous process of improvement to which everyone can contribute. It can be done either internally or externally. External safety audit is more effective at compliance to the regulations. Opportunities for improvement raised during the audit can be carefully considered and used to improve the implementation of the existing systems in each and every radiation facility in Malaysia whenever appropriate. The effectiveness of regulatory system in Malaysia can be improved further through implementation of Integrated Radiation Safety Management, IRSMS that is seen as a competitive product to meet the current and future needs in sustainability of radiation

Topical Issue 1: Role of TSOs in enhancing nuclear and radiation safety

safety. As a result, safety culture, which has been a vital element on safety can be improved and utilized to promote changes from good safety performance leading to excellence.

References

1. General Principles for the Radiation Protection of Workers, Annals of the ICRP, Vol.21 No.1 1997.
2. Key Practical Issue in Strengthening Safety Culture, INSAG-15, IAEA, 2002.
3. Management Systems For Technical Services in Radiation Safety, IAEA Safety Standards, Safety Guide DS315, 2005.
4. Muhamad Lebai Juri, Radiation Safety Audit, 2nd Asian Oceanic Congress on Radiation Protection, Beijing, 9-13 October 2006.
5. Noriah Mod Ali, Trends of Occupational Exposure in Malaysia, 11th International Congress on Radiation Protection, Spain, 23-28 May 2004.

Neutron detector based on nuclear-optical converter

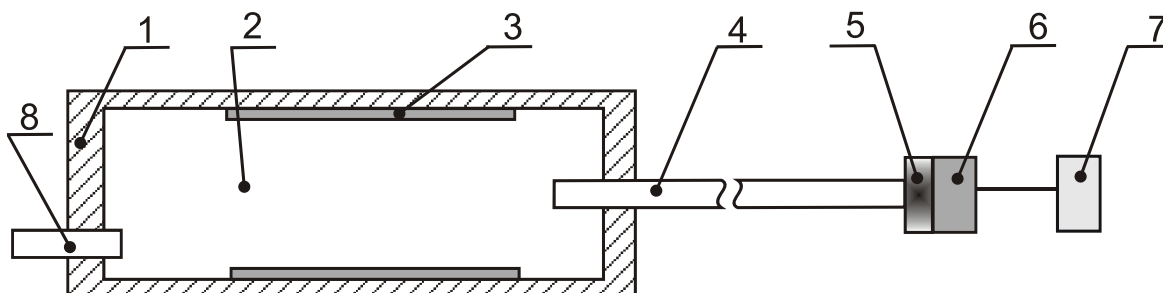
Gorbunov V.V., Dovbysh L.E., Melnikov S.P., Sinitsyn A.V., Sinyanskii A.A.

Russian Federal Nuclear Center –
All-Russia Scientific Research
Institute of Experimental Physics
RFNC-VNIIEF,
Sarov, Russia

Abstract. Authors offer the new type of a neutron detector – the nuclear-optical converter (NOC). Principle of detector operation lies in conversion of kinetic energy of uranium fission fragments arose from nuclear reaction into luminescent light. Such a detector has several advantages in comparison with traditional detectors based on gas discharge: absence of supply voltage on the detector, absence of long length wire lines, noiseproof transmitting of signal from a reactor core, an opportunity to split signal from detectors on different recorders without deterioration of channel reliability and integrity, an opportunity to use NOC as an element of a reactor fast acting safety system.

Neutron flux density is one of parameters of a nuclear reactor, which defines state of a reactor core and radiation environment in reactor rooms. Nowadays fission chambers are used for neutron flux monitoring on nuclear reactors [1]. Such detectors are used in a preparatory mode of reactor startup to monitor reactivity and starting power. They are also used in systems of neutron flux monitoring during operation on full-power. Disadvantages of fission chambers are necessity to ensure power supply in irradiation areas and long length wire lines between fission chambers and measuring equipment where noise signal are generate as a results of radiation and electromagnetic action.

Investigations on spectral-luminescent characteristics of different media excited by uranium fission fragments have been carried out in VNIIEF during approximately last 30 years within the bounds of study of nuclear pumped lasers [2]. Results of these investigations allow making a proposition about an opportunity of development of a new type of a neutron detector – a nuclear-optical converter (NOC). Principle of detector (fig.1) operation lies in conversion of kinetic energy of uranium fission fragments arose from nuclear reaction: $^{235}\text{U} + n \rightarrow \text{fission fragments} + 170 \text{ MeV}$ into luminescent light. Light with help of a fiber is transported through reactor biological shielding to optical detector. Noble gases and their mixtures having high resistance to nuclear radiation are proposed to use as a working medium.



1 - detector body; 2 – gas medium; 3 - fission fragment source; 4 - fiber; 5 - filter; 6 - photodetector; 7 - wide-range system of neutron flux measuring; 8 – fill nipple.

Fig. 1. Structural layout of detector based on NOC

Direct monotone dependence of luminescence power on neutron flux in the range of 10^8 - 10^{16} $\text{cm}^{-2}\cdot\text{s}^{-1}$ was proved in numerous experiments carried out on nuclear installations of VNIIEF.

During development of the neutron detector based on NOC there were solved several problems: selection of the working medium having luminescence efficiency dependence on neutron flux close to linear one, development of manufacturing methods of thin-film uranium layers, selection of fibers to transport luminescent light through reactor biological shielding with minimal loss.

Preliminary investigations proved that it is possible to develop neutron detectors based on NOC.

Such a detector has several advantages in comparison with traditional detectors based on gas discharge: absence of supply voltage on the detector, absence of and long length wire lines, noiseproof transmitting of signal from a reactor core, an opportunity to split signal from detectors on different recorders without deterioration of channel reliability and integrity, an opportunity to use NOC as an element of a reactor fast acting safety system.

The neutron detector prototype used in our experiments showed its operability in a wide range of measured neutron flux densities.

Gas NOC can operate as nuclear particle detectors in different modes: the pulse counting mode, when flux density of detecting particles is proportional to pulse frequency of the photoreceiving device of the detector; the mode of quasicontinuous radioluminescence and the lasing mode, when power of luminescence and lasing linearly depends on power of energy deposition in gas and neutron flux density.

REFERENCES

- [1] Malyshev E.K., Belozerov V.G., Shetinin O.I. // Wide-range fission chamber for safety and control systems of nuclear reactors. // *Atomnaya energiya*, v. 47, No. 4, 1979, pp. 271-273.
- [2] Gorbunov V.V., Grigorev V.D., Dovbysh L.E., Melnikov S.P., Sinitsyn A.V., Sinyanskii A.A., Tsvetkov V.M. Luminescence of He, Ne, Ar, Kr, Xe and their mixtures He-Ne, He(Ne)-Ar, He(Ne,Ar)-Kr, He(Ne,Ar,Kr)-Xe in visible spectrum under excitation by uranium fission fragments // Transactions of the third international conference "Problems of nuclear pumped lasers and pulsed reactors". – Snezhinsk, 2002. – pp.12-13.

Development of training simulator based on critical assemblies test bench

**Narozhnyi A.T., Vorontsov S.V., Golubeva O.A., Dyudyaev A.M., Il'in V.I.,
Kuvshinov M.I., Panin A.V., Peshekhonov D.P.**

Russian Federal Nuclear Center –
All-Russia Scientific Research
Institute of Experimental Physics ,
RFNC – VNIIEF
Sarov, Russia

Abstract. When preparing critical mass experiment, multiplying system (MS) parts are assembled manually. This work is connected with maximum professional risk to personnel. Personnel training and keeping the skill of working experts is the important factor of nuclear safety maintenance. For this purpose authors develop a training simulator based on functioning critical assemblies test bench (CATB), allowing simulation of the MS assemblage using training mockups made of inert materials. The control program traces the current status of MS under simulation. A change in the assembly neutron physical parameters is mapped in readings of the regular devices. The simulator information support is provided by the computer database on physical characteristics of typical MS components. The work in the training mode ensures complete simulation of real MS assemblage on the critical test bench. It makes it possible to elaborate the procedures related to CATB operation in a standard mode safely and effectively and simulate possible abnormal situations.

The works on experimental study of critical systems made of fissile materials (FM) have been performed in VNIIEF since the late forties. The experiments were conducted on special critical test benches (CTB). Presently, critical mass studies are being conducted on FKBN-2M critical assembly test bench [1].

When preparing any critical mass experiment, multiplying system (MS) parts are assembled manually. This experimental phase is connected with maximum professional risk to personnel. An error leading to premature achievement of the critical state can lead to over-dosage and, possibly, death of personnel [2].

The analysis of nuclear accidents demonstrated that the solution of the problem of nuclear safety provision while treating FM is impossible in no terms of human factor account. The key issue here is the one of personnel training and keeping the skill of working experts. The required qualification and experience are achieved as a result of multi-year activities with MS. As the training is realized on the operating facility the elaboration of erroneous and abnormal situations is possible in theory only. One of hardware items capable to make the expert training quality higher and shorten the time of mastering the MS manipulation technology is the training simulator allowing simulation of the MS assembly on the FKBN-2M critical test bench. Moreover, in the course of assembling of the training (inert) MS mockups the operational staff actions corresponding to regular operations are reproduced and the response of MS is demonstrated for the case of operator mistake and abnormal situation occurrence.

The technique of the critical test bench simulator development consists in the following. Functioning CTB FKBN-2M and its technological accessories, including the Control and Protection System (CPS) are used for the basic equipment.

Experience and operating regulations on CTB FKBN-2M are used as methodical support at the development of simulator operation algorithms. The simulator information support is provided by the computer database on physical characteristics of the MS components (geometry, mass and isotopic composition, nuclear physical constant sets, etc.).

Calculated and available experimental data on the current MS status are put into the simulator data bank. Development of the computer simulation of MS is carried out on the basis of computer codes using the Monte-Carlo method and libraries of neutron constants BAS and ENDL-82. Modelling of the “free run” processes in MSes realizes on basis of solution of the one-point kinetics equation, taking into account temperature factor of reactivity reduction as well.

The base information environment of the computational model is formed in combination with the functions of MS component spatial position variation during the assembling.

At the experiment preparation phase, in order to develop regulations for the future operations or training, the MS is assembled on display. Depending on configuration of MS being simulated the data array of the computational model is activated. The current status of MS as well as the values of leakage neutron flux density, source neutron multiplication factor, reactivity corresponding to this state is reproduced on the display at a certain discretization step.

The MS assembly techniques is verified directly on the test bench using training mockups made of inert materials (marked with bar codes for linking with imitated real parts). The work in the training mode involves all mechanisms and CTB regulation organs used in standard operation mode. A change in the assembly neutron physical parameters is mapped in readings of the regular devices. The control program traces the current status of MS under simulation and predicts its status for the next assemblage step specified by the operator. The operating regulations established for the assembly are observed. In case of operator's improper actions, alarm signals and information messages are issued.

The proposed method ensures complete simulation of a real MS assemblage on the critical test bench. It also makes it possible to safely and effectively elaborate the procedures related to CTB FKBN-2M operation in a standard mode and simulate possible abnormal situations.

REFERENCES

- [1] Kuvshinov M.I., Voinov A.M. and Zagrafov V.G.. “The History of Works on Nuclear Criticality Safety in RENC-VNIIEF”, in Proc. 5ICNC-95 (Albuquerque). P.12-22.
- [2] McLaughlin T.P., Monahan S.P., Pruvost N.L., Frolov V.V., Ryazanov B.G., Sviridov V.I. “A Review of Criticality Accidents. 2000 Revision,” LA-13638 (2000).

Process of Upgrading the Radiation Protection Services in R.Macedonia

L.Nikolovska

Radiation Dosimetry Department –
Republic Institute of Health Protection,
Skopje, Republic of Macedonia

Abstract. The utilization of radiation to be safe, reliable, and clean and environment friendly needs sufficient resources. Sufficient sources for national infrastructure could be professionals in radiation safety, laboratory and service facilities. These facilities and services are needed for intervention, calibration and intercomparison of radiation measuring equipment, personal dosimetry, environmental monitoring, and radioactive waste management. Radiological protection services need to be exercised in a manner that provides the most benefit to licenses and to society to. It should not be too little or too much; it has to be prudent, well based, equitable, and open. And it must be relevant. Based on the analyses of national situation of applications of radiation sources and national technical and professional resources, a centralised approach of radiation services positioning in the radiation legislation has been followed. By the Act, the existing services within the Republic Institute of Public Health Protection have been organized as the Radiation Protection Centre and are defined as a professional and technical service provider. The activities of Radiation Protection Centre are fulfilled through three departments: Radiation dosimetry, Radioecology and Labour medicine department. By the Act, the waste management service has to be established through National waste storage facility for low and intermediate waste.

1. Introduction

The safety in the use of radiation sources, security of facilities where radiation sources are used and sources of ionizing radiation, radiation protection, and the safe management of radioactive waste as well as safe transport of radioactive material are of great importance to individuals and society and to the environment in the Republic of Macedonia.

Republic of Macedonia recognizes that the achievement and maintenance of a high level of safety in the use of radiation sources depend on there being a sound legal and governmental infrastructure.

2. Radiation Safety Framework

After gaining its independence, Republic of Macedonia was faced with problems connected to the restructuring of a national legislation, infrastructure in economy, environmental protection, social system, health care and many other fields. All areas of life had to be reconstructed aimed at obtaining the same level as those existing of international standards. Although radiation protection was not a top priority, the Republic of Macedonia has been taking steps to ensure protection of its population from harmful effects of ionizing radiation. Also, the recommendations of the ICRP, requirements of the IAEA and the European Commission had to be implemented.

The legislative framework for radiation safety is provided through the Law on Ionizing Radiation Protection and Safety, adopted by the Macedonian Parliament in June 2002. Based on the Law, Radiation Safety Directorate (RSD) as an independent Governmental Body was established in 2005.

The mission of RSD is to ensure adequate protection of public health and safety and protect the environment by regulating, keeping and updating the National register of sources and practices, licensing, and inspection of any activity with radiation sources unless excluded or exempted.

3. Radiation Protection Centre

The utilization of radiation to be safe, reliable, and clean and environment friendly needs sufficient resources. Sufficient sources for national infrastructure could be laboratory and service facilities. These facilities and services are needed for intervention, calibration and intercomparison of radiation measuring equipment, personal dosimetry, environmental monitoring, and radioactive waste management. Radiological protection services need to be exercised in a manner that provides the most benefit to licenses and to society to. It should not be too little or too much; it has to be prudent, well based, equitable, and open. And it must be relevant.

Based on the analyses of national situation i.e. small country with no nuclear applications, limited number of applications mainly in medicine and industry, less than 1300 radiation workers, limited number of qualified professional resources and optimal investment of existing recourses, a centralised approach of radiation services positioning has been followed. By the Act, the existing services within the Republic Institute of Public Health Protection have been organized as the Radiation Protection Centre (RPC) and are defined as a professional and technical service provider. The activities of Radiation protection centre are fulfilled through three departments: Radiation dosimetry, Radioecology and Labour medicine department.

Since 1995 the services offered through Radiation protection centre are continuously upgrading and developing, based on prioritization principle and available recourses. The major support in developing, upgrading or strengthening the existing services was through participation in IAEA Model Project, Regional technical assistance and through IAEA National Technical cooperation projects

3.1. Occupational radiation protection monitoring

The objective of the RPC-Radiation Dosimetry Department as a service provider in occupational radiation protection is to ensure an appropriate control of normal and potential occupational exposure from both artificial sources and natural sources of radiation through provision of services for assessment of occupational exposure due to external sources of radiation and operational radiation monitoring activities and field services.

The RPC-Radiation Dosimetry Department maintains a facility for the evaluation of the radiation dosimeters which are used to monitor whole body exposure of 1200 and exposure to extremities of 200 occupationally exposed workers in Republic of Macedonia. Introduced in 1995 and upgraded in 2006 the laboratory operates one Harshaw 6600 TLD reader workstation and one Harshaw 4500 TLD reader workstation.

Operational radiation monitoring services through workplace monitoring activities at licensee's premises and regular peer review are to ensure satisfactory working conditions in the radiation practices carried out by the licensee. Regular implementation of a survey programme by the Department and providing on site expert advices provides opportunity for timely corrective actions for safety performance.

Operational radiation monitoring group gives advisory, technical and support in education and training to State Customs and Police Department for radiation control of imported metal scrap, illegal trade of radioactive material and to Rescue Directorate in emergency planning.

Expert advice and assistance for creation of radiation protection programs, emergency plans as well verification and evaluation of the licensee's radiation protection programme, classification of workplaces, classification of workers, is provided by the members of Medical Physics Society and Society of Applied Physics.

3.2. Calibration service

The Calibration laboratory for radiation protection level dosimetry was set up in 2005 within RPC-Radiation Dosimetry Department. Traceability of measurements to the International Measurement System was established. This improved the accuracy in radiation dosimetry in the country and started the process of establishing confidence in radiation protection measures. The calibration laboratory participated in inter-calibration audits run by IAEA and in April 2006 RPC became a member of SSDL Network.

3.3. Radioecology

RPC-Radioecology Department performs regular monitoring of contamination of human environment through total alpha, total beta, gamma spectrometry, radiochemical separations and other measurements of environmental samples.

Measurement facilities are equipped for gamma spectrometry, high sensitivity beta radiation measurements, and alpha particle spectrometry and radioanalytical procedures for determination of Sr-90 and U in environmental samples. New analytical radiochemical procedures are developed when necessary. The Project for continuous gamma dose rate monitoring and radon monitoring in human or working environment has started this year.

3.4. Medical surveillance

Regular medical surveillance of the radiation workers forms part of the general occupational health protection policy in the country. The surveillance programme of radiation workers at the national level was established in 1970s within Labour medicine Department continuously improving and upgrading its services. The centralised records of annual medical checks of all radiation workers in the country are to be kept until their age of 75.

4. Conclusion

A fundamental component of radiation protection and safety are the availability of adequate, relevant and sustainable services with educated professionals, measurement equipment and techniques as well as modelling and assessment methods and software. Based on the criteria of prioritization and optimisation most of the services in Republic of Macedonia were developed. The necessary further improvements are foreseen for waste management, medical exposure and training services.

Although developed, the existing services have to be accredited by the National Accreditation Authority in order to maintain quality, ensure compliance with regulations and international recommendations and most of all to establish confidence among the licensees, workers and

general public.

All of these components are of great importance having in mind the responsibility of the professionals providing services for assuring that radiation safety and risk are understood, that are managed, the risk is kept low, and that it is effectively communicated.

REFERENCES

- [1] Food and Agriculture Organization of the United Nations, International Atomic Energy Agency, International Labour Organization, Pan American Health Organization, World Health Organization, International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources, IAEA Safety Series No.115. IAEA, Vienna (1996).
- [2] Law on Ionizing Radiation Protection and Radiation Safety, Official Gazette No. 48/02, June, 2002.
- [3] Council Directive 96/29Euratom of 13 May 1996 Laying Down Basic Safety Standards for the Health Protection of the General Public and Workers Against the Dangers of Ionizing Radiation. Official Journal of the European Communities No. L 159, Luxembourg (13 May 1996), 1 –114.

CURRENT STATUS OF THE REGULATIONS OF THE NUCLEAR ACTIVITIES AND ACTIVITIES INVOLVING IONISING RADIATION SOURCES IN THE REPUBLIC OF MOLDOVA

Artur BUZDUGAN,
Supreme Council of Science and Technological Development,
Academy of Sciences, Chisinau, Republic of Moldova

Abstract. The paper gives a brief overview of the Moldovan regulatory framework and the authority implementing it, as well the main principles guiding the authorization process. The interaction of the regulatory body with scientific infrastructure is assured through consultative National Radiation Protection Committee (NRPC) under the Government. Also, there is presented the national priority in nuclear and radiation technologies.

National Infrastructure and Regulatory System. The first law regarding radiation protection and nuclear safety was adopted in December 1997. According to the laws, the regulatory system was split among five national regulatory authorities: Ministry of Health, Ministry of Ecology and Natural Resources, State Service on Standards and Metrology and Department of Emergency Situations. The licenses are issued by the Chamber of Licensing, but most radiation facilities required previously two authorizations for operation: from the Ministry of Health and from the State Service on Standards and Metrology. Taking into account the existing five regulatory bodies, there were adopted additional Government Acts: Regulations regarding the organization of activity of regulating bodies in the area of radiation protection and nuclear safety and of the above mentioned NRPC.

The Republic of Moldova has established in 1997 a National Radiation Protection Committee as the highest governmental consultative advisory body dealing with the nuclear matter. The NRPC consists of specialists and researchers from different fields linked with nuclear and radiation technologies and is chaired by the Vice-Prime Minister. The Vice-Prime Minister has designated, for its part, the President of the Academy of Sciences to act as the main counterpart for all IAEA matters. Until 2007 the NRPC plays also the role of interface between different regulatory bodies from the country and determines the domestic priorities in nuclear transfer technologies. According to his Statute, the NRPC is responsible for the final expertise and selection of projects to be funded by the IAEA. We would like to mention that central criteria for consideration during appraisal of the national projects are:

- the orientation towards an end-user;
- to respond to a major need of the country;
- to be realistic;
- strongly sustained by the Government;
- visible socio-economic impact;
- significant role of the nuclear technology in sustainable development.

Establishment of an independent and efficient regulatory authority with adequate infrastructure and resources was recognized as government priority the last two years. In these views, on May, 11, 2006 was approved the new law #111-XVI "On safe nuclear activities and activities involving ionizing radiation sources". According to this law, in the country, will be established a single regulatory body - National Agency of Regulation of the Nuclear Activities and of the Activities with Ionizing Radiation Sources (the Agency). The Agency will be affiliated to the Ministry of Ecology and Natural Resources, but with the necessary financial and decision independence in the matter. The Agency will be responsible for the authorization, review and assessment on regulation and other normative acts,

inspection and enforcement. However, issuing, suspending or revoking of licenses remains in the competence of the Chamber of Licensing.

In spite of corresponding of the new law to the main international recommendations, the deficit of the state budget did not allow till present to establish the Agency.

The principles of authorization. According to the new law the following major activities are subject to prior authorization by the Agency:

- manufacturing of radionuclide or of products or devices containing them;
- distribution of radioactive sources;
- import or export of radioactive sources;
- hold or use of radioactive sources;
- storage of radioactive sources and of radioactive waste

The authorization will be issued if beneficiaries respect fully conditions of legal acts and norms in matter. The Agency pursues the following objectives:

- to verify that the practice is justified;
- to be sure that security and radiological protection measures are implemented during the use of the sources;
- to notify the general or specific prescriptions to be followed by the beneficiary of the authorization.

Authorization is delivered under the form of license or certificate of registration, depending on categorization of used radioactive source. Certificate of registration is issued by the Agency, but the license – by the Chamber of Licensing on the base of written notification of the Agency. A license may be issued for limited fields of activities and for maximum of five years. All services offered by the Agency to the licensees are free of charge.

Inspection. A specialized inspection department, radiation safety inspectors are established by the new law too. This department is planned to be in the framework of the Agency and is subordinated directly to the General Director. The inspectors will perform inspections in addition of those already performed by the labor inspection and by the Center of Preventive Medicine, who are not specifically focused on radiation safety issues. Domestic legislation suggests that all mentioned inspections are recommended to be performed simultaneously.

The radioactive waste management has been improved the last years through upgrading the radioactive waste repository from the Chisinau City. The upgrading included the assurance of pre-treatment (segregation), treatment and conditioning of solid and liquid waste, the establishment of subsurface temporary storage of spent high-activity sealed sources and QC techniques. Also the environmental monitoring surrounding of the repository has been established. The upgrading meets existing and future demands for radioactive waste management in accordance with international standards and criteria. A new waste storage for the low level waste was designed and constructed. As per three parties' initiative (USA, Russian Federation and IAEA) a new storage facility for the high activity radioactive sources was commissioned, a new physical protection system was established; some high level radioactive sources were removed from the country through the IAEA and USA assistance.

Metrology. The National Institute of Standards and Metrology is responsible for the state policy in the field. But, for the nuclear techniques applications field its laboratory is not equipped enough. At present time, is on going the IAEA project regarding the establishment of a Calibration Laboratory for Radiation Dosimetry.

Categorization of sources. Until present there are no official categorizations of sources in the country. Regarding the new adopted law, the categorization of sources will be done in full compatibility with the categorization used in the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and in the IAEA Safety Guide # RS-G-1.9.

National inventory. The Agency will manage the Central Register of Ionizing Radiation Sources which involves information regarding sources, licenses, licensees and controls. The duplicate of the electronic form of the Register are also in the Department of Emergency Situations and in the National Center of Preventive Medicine.

Establishing capabilities for **emergency preparedness and response** at the national levels are under the responsibilities of the Department of Emergency Situations from the Ministry of Internal Affairs. The department has a qualified staff and centralized emergency communication room which works on a 24 hour basis. The Department is also involved in the national monitoring network of radiological pollution of the environment.

Nuclear power status. The Republic of Moldova has no nuclear power plants and currently has no plans for the construction of the nuclear power plant. But the problem may be reviving, because there is a strong dependence of the country's economy on the import of energetic resources.

Science and technology transfer policy. National science is formed around the Academy of Sciences. The Academy of Sciences is nominated as the sole public authority of the national significance in the field of science and innovations, plenipotentiary coordinator of scientific and innovation activities, supreme scientific forum of the country and scientific consultant of the public authorities of the country. Any domestic scientific institution or organization (including University Departments, Laboratories, etc.) may obtain budget financial support only on competition base through the Supreme Council for Science and Technological Development of the Academy of Sciences. The Academy of Sciences is in the process of reform and nowadays has the structure of six thematic scientific divisions (in economy and mathematics; biology, chemistry and ecology; physics and engineering; medicine; agriculture; humanitarian and arts), institutional, profiled or affiliated members. In 2005 within the Academy of Sciences were organized the National Agency for the Technology Transfer, the Center of Expertise, the Center of the International Projects and the National Agency for Intellectual Property. By the law No 259-XV from 15.07.2004 the Code on Science and Innovations was approved. This code regulates legal relations, connected with elaboration and implementation of the state policy in the field of science and innovations.

At present time the supervision of the relations with the IAEA are carried out by the national liaison officer from the Academy of Sciences.

Nuclear research. In 1972 the State Agrarian University of Moldova constructed a Gamma Field designed to study the impact of gamma radiation on the genetic structure of plant cells. It was the largest in Europe Co-60 irradiator and was used for research in radiobiology. The irradiator is out of service and stored in the repository. In 1997 the Laboratory of Radiobiology was established at the same University. At the Ministry of Agriculture and Food Industry there is a Center of Applied Pedology with the Radiation Control Laboratory, responsible for the control of safe use of radiation sources in agriculture. This Laboratory is part of the national network of environmental monitoring (soil monitoring, and of the vegetable and zoo technical products) and studies also the impact of the radionuclide on the agrocenose.

A 25 MeV electron accelerator has been partially installed (Microtron-25, Dubna production) in the Experimental Center “Biotron” of the Institute of Genetics and Plant Physiology of the Academy of Sciences. This accelerator originally designed for research in radiobiology was intended for the production of short and medium life radioisotopes for medical treatment. Despite strong support for the local production of radioisotopes, and support from the IAEA, completion of the project has been suspended due to lack of resources in the country. In the framework of this Institute there is a Radiobiological Laboratory also equipped with gamma source.

In the Nuclear Physics Laboratory of the Institute of Applied Physics are studied theoretical problems of nuclear physics and their practical applications. Scientific studies are carried out in cooperation with partners from Russian Federation, France, and Ukraine.

The National Scientific Practice Center of Preventive Medicine studies biological and medical effects of ionizing radiation on human health. The Center is also responsible for the hygienic norms of the radiological factors, medical supervision of the nuclear & radiological activities in the country and for monitoring of professional exposed personnel.

The State Service “Hidrometeo” is responsible for the monitoring regarding radioactive pollution of the environment and for the scientific studies of its influence on the natural ecosystem.

Nuclear and isotope technologies in medicine. Within the last 10 years the Oncological Institute obtained a new Treatment Planning System, simulator, computed Tomography system, THERAPAX X-ray therapy system, new Cobalt-60 sources to refurbish radiotherapy units and essential dosimetry facilities to ensure optimal dosage to radiotherapy patients. But some of the available radiotherapy facilities are in need of upgrading or replacement. The structure and organization does not correspond fully to international standards and the staff of the radiotherapy department should get additional training. There are currently three nuclear medicine facilities: Center of Nuclear Medicine, Republican Center for Medical Diagnostic and Scientific Center of the Health Protection of Mother and Child. The Center of Mother and Child involves the only laboratory in the country where children are examined. The last two mentioned Centers were recently equipped with IAEA support by the new modern Gamma cameras.

Near-term future policy. The Government considers nuclear and isotope techniques as an important component of the national policy in science, technology and human health, contributing to the development of the major national program. It is the Government’s policy to improve applications of non-power nuclear technology, assure radiation protection and safety, fully establish the regulatory framework and infrastructure in line with international obligations, harmonize the legal basis in nuclear area with international legislation and requirements and to make maximum use of the strength of the IAEA technical assistance to deal with national needs and priorities.

The following priority areas of future (2005-2012) focus of Technical Cooperation projects with the IAEA were identified in 2005 in the signed CPF agreement:

- Modern nuclear technique in human health (LINACS and PET technologies, OA & QC in radiotherapy and radio-diagnostic).
- Radiation processing for medical, pharmaceutical and cosmetic supply & for food industry, in other branches of science.
- Nuclear technique in agriculture for sustainable land water management, crop protection and improvement & for investigation of water resources.
- Continued capacity building for the strengthening of an adequate nuclear & radiation safety infrastructure.
- Human resources development and preservation.

International cooperation. The Republic of Moldova became a member of the IAEA in 1997 and cooperates very fruitfully with the Department of Cooperation and Department of Safeguards. The international relations of the Republic of Moldova are also based on the following international treaties and agreements (table I):

Table I

	in force	status
Vienna Convention on Civil Liability for Nuclear Damage	1998-08-07	Accession 1998-05-07
Convention on the Physical Protection of Nuclear Material	1998-06-06	Accession 1998-05-07
Convention on Early Notification of a Nuclear Accident	1998-06-07	Accession 1998-05-07
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	1998-06-07	Accession 1998-05-07
Convention on Nuclear Safety	1998-08-05	Accession 1998-05-07
Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA)	1998-09-24	Signed 1998-09-24
NPT		Signed 1996-07-08
CTBT		Signed 1997-10-24
Strengthened Safeguards Systems: Status of Additional Protocols	2006-09-13	
Code of Conduct on the Safety and Security of Radioactive Sources		is accepted

Conclusions. The infrastructure of radiation protection in the Republic of Moldova, after its complete reorganization, will reflect the international standards for radiation protection. All radiation and nuclear related activities will be regulated and registered by the National Agency for Regulation of Nuclear Activities and Activities with Radiation Sources, under the Ministry of Ecology and Natural Resources. The Agency will have necessary financial and decision-making independence in the matter. The structures, the Regulation and the Head of the Agency are approved by the Government. The new concept of state system for control of radioactive sources is based on the registration, licensing, on-site inspection, national source inventory and corresponds to the international standards.

The science and innovation infrastructure is in a stage of radical reorganization the last two years. Interaction of science community and regulatory body is assured through the National Radiation Protection Committee, as the consultative body of the Government.

International cooperation is being supported. The Republic of Moldova signed the CPF, a bilateral agreement with the IAEA Department of Technical Cooperation, which underlined state priorities and the necessity to implement in the near future nuclear and isotope technologies in the country.

Country's annual budget (USD ~3 mlrd, the poorest country in Europe) did not assure fully, adequately and timely implementation of the international recommendations in the fields of radioprotection, nuclear safety & promotion of scientofage technology in economy. In this way the multilateral international assistance for the Republic of Moldova would be required for the medium term in establishing a fully corresponding to international standards regulatory body, adequate implementation of the international treaties and agreements on the matter, and in helping the development of human resources and transfer of new nuclear technology in medicine, industry, agriculture and science.

Technical and Scientific Support of Nuclear Power Development in Belarus

Alexander Mikhalevich

Scientific Center on Energy Efficiency,
Luikov Institute of Heat and Mass Transfer,
National Academy of Sciences of Belarus,
Minsk, Republic of Belarus

Abstract. In the end of 1986 the construction of the first NPP in Belarus was stopped after Chernobyl accident but investigations in the nuclear field were continued. Recently the decision about nuclear power development has been accepted again. Therefore at present technical and scientific support of managerial, administrative and organisational decisions and activities in this sphere is of great importance.

1. Introduction

Republic of Belarus, as a part of the Soviet Union, having highly energy-intensive economy and few indigenous fuel and energy resources has been initially oriented towards nuclear power. Four nuclear power plants with total capacity of about 12GW have been constructed near the borders of the Republic. In Belarus the constructing of nuclear CHP not far from Minsk and the planning of NPP construction in Vitebsk region have been begun. The Chernobyl NPP accident has stopped this Program.

On the other side the Republic of Belarus has been suffered from the Chernobyl accident most of all other countries including Russia and the Ukraine. About a quarter of its territory and population had turned out in the radioactively contaminated zone. The attitude of a considerable part of the Belarus population towards the nuclear energy is aggravated with the consequences of this accident.

In this respect the not only decision about construction of NPP in Belarus but further activities in this field require the adequate scientific and technical support.

At present the Program on Technical and Scientific Support of Nuclear Power Development in Belarus is being formed. The organizations which provide the Technical and Scientific Support (TSO)s of Nuclear Power in Belarus are following:

- Joint Institute of Power and Nuclear Research/National Academy of Sciences of Belarus
- Belarus Thermal and Power Institute
- Belarus Institute of Energy Industry
- Luikov Institute of Heat and Mass Transfer/National Academy of Sciences of Belarus

The scope of the Program include the following issues:

- Strategic energy planning
- Legislative and regulatory base of nuclear development
- Independent technical and scientific advice for decision making
- Technical and scientific examination
- Investigation of expertise of other countries
- Emergency preparedness and response
- Public information and public acceptance
- Education and training, *etc.*

2. Strategic energy planning

Up to recent years the methodology of energy planning at the national and local levels has been mainly based on economical criteria taking into account environmental restrictions, *eg.*

computer code WASP (Wiena). But at present the energy security aspects become more and more significant.

Table 1. Primary fuel consumption in Belarus

Fuel	Amount (Mtoe)
Natural gas	16.40
Liquefied gas and liquid fuel	0.69
Heavy fuel oil (mazut)	1.22
Coal	0.15
Peat	0.47
Fired wood	0.86
Others	0.41
Total	20.20

Energy security implies the availability of energy, in its different forms and at all times, to users in sufficient quantities and at reasonable prices during normal period as well as in required quantities during accidents.

New threats to energy security have appeared in resent decades: unpredictable grows of world and local oil and gas prices, large scale disruptions of electricity supply in consequence of technical and enviromental emergencies, deregulation of energy systems in some countries (*e.g.* NIS) *et al.*

At present total installed electric power capacity in Belarus is 7900 MW including only one advance combined cycle heat and power plant (CHP) with capacity of 70 MW. In 2005 total consumption of electricity was 35.0 TW·h, production of heat – 308 PJ. The structure of primary fuel consumption excluding transport is presented in Table 1.

The lack of domestic power and fuel resources and critically high share of imported natural gas are the main threats to energy security in Belarus. The diversity of a fuel supply can be acheved by including of coal or/and nueler power in energy balance.

The results of calculation are shown that electricity system expansion plan based on utilization of coal as a fuel has the highest generation cost. Implementation on nuclear power will allow decreasing generation cost up to 3.26 cents/kWh. Optimal solution includes construction of nuclear units with total capacity of 2000 MW to 2020 year. The first unit has to start in commercial operation in 2015.

These results were put into the base of the Concept of Energy Security of the Republic of Belarus up to 2020 and State Complex Program on Modernization of the Belarus Energy System in 2006-2010 which were approved by the President of the Republic of Belarus (2005).

3. Legislative and regulatory basis

At present the draft of Law “On Nuclear Energy Use” is preparing. During this work we were takig into account the Legislative basis of Russia, Lithuania, France, Ukraine and Bulgaria. This Law shall establish:

- the basis for the management of nuclear energy;
- the principles of state regulation of nuclear safety and radiation protection in the sphere of nuclear energy;
- basic conditions for licensing in the sphere of nuclear energy;
- special conditions for the construction of nuclear facilities;
- basic conditions for operation of nuclear facilities;
- basic conditions for export and import of nuclear materials and equipment;
- basic conditions for transportation and storage of nuclear and radioactive materials used in the sphere of nuclear energy;

- basic requirements for the physical protection of nuclear facilities and nuclear materials;
- basic requirements for the prevention of and response to nuclear and radiological accidents;
- the principles of liability in the sphere of nuclear energy;
- the basic economic and financial conditions in the sphere of nuclear activities;
- the specific features of labour relations in the sphere of nuclear energy.

4. Public acceptance

During 1995-2005 the sociological monitoring of public opinion about nuclear safety of the existing NPPs and further nuclear power development was provided in Belarus. The first poll (1995) was conducted among inhabitants of the more “pure” region in the Republic - the Vitebsk one (34.8% respondents), as well as in the regions contaminated with radionuclides - the Gomel region (32.7%) and the Mogilev region (32.5%). 38.8% of the polled persons declared in favour of nuclear power development and 20.3% of the polled ones declared decommissioning of all operating NPP in the territory of CIS.

Approximately half of the opponents of nuclear power (50.5%) explained their negative attitude, in some way or other, by the apprehension of risk increasing for people’s health becoming worse.

The second (1999) and third (2005) sociologic surveys involved the inhabitants of the whole territory of Belarus including the capital of the Republic - Minsk city. From the total number of respondents 83.6% constituted townspeople, 43.3% - engineering and technical personnel, 15.5% - workers, 13.6% - the pupils and the students; 54.9% had higher education, 23.9 - specialized secondary education; 68% were at the age from 21 to 50.

The main question of the questionnaire “Should the project of NPP construction be adopted in Belarus?” was answered in a following way: 40.9% in 1999 and 28.3% in 2005 of the respondents answered “Yes”, 39% (1999) and 46.7% (2005) - “No” and 19.2% (1999) and 25% (2005) of the respondents were embarrassed to answer.

In this connection, it is interesting to examine the distribution of opinions as to various categories of the questioned persons (Fig. 1). The more negative attitude towards nuclear power has the inhabitants of the Brest region which has been partially suffered from the Chernobyl NPP accident, opinions of the inhabitants of “pure” Vitebsk region and the more contaminated Gomel and Mogilev regions are less negative and vary between themselves a little bit, the more positive attitude is shown by the respondents living in the capital of the Republic.

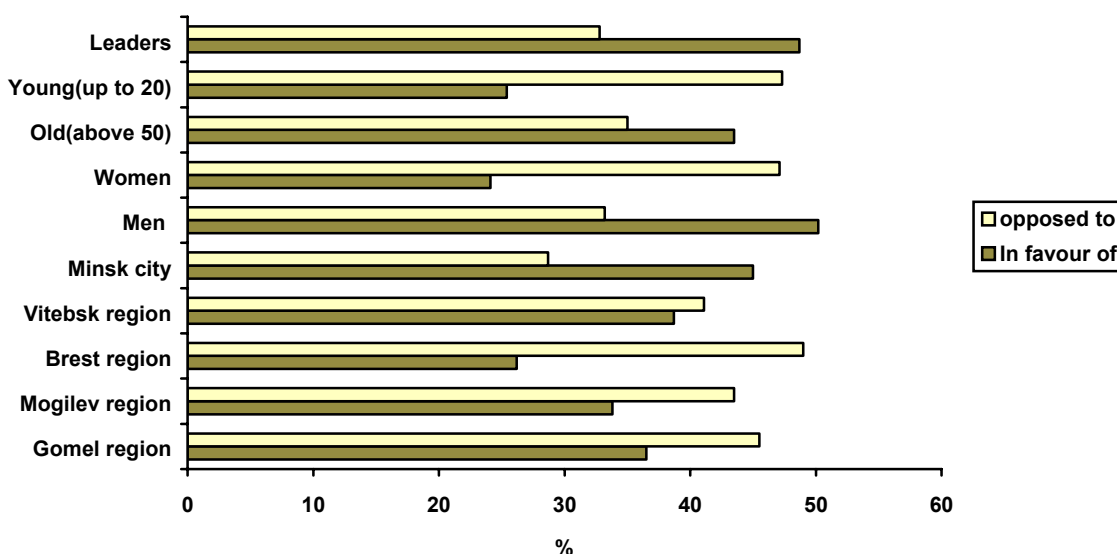


Fig. 1. Opinion on the NPP construction in Belarus

Supporters of nuclear power are absolutely more among men, and relatively - among the leaders of different ranks and persons older than 50, less- among women and the youngest participants of the inquest at the age of up to 20.

As it is seen from the results above-given, they have turned out to be not logically adequate in all to the situation having been established in Belarus. One of the explanations of this phenomenon is the answer on the question “Is the population informed on the problems of nuclear power sufficiently?”. An absolute majority (89.1% in 1999 and 84.3% in 2005) of the interrogated persons answered “No”.

Among the sources the received from the IAEA and other specialized international organizations (Fig.2) information is trustworthy most of all among the participants of the inquest, home scientists and specialists are trusted less than the foreign ones, and mass media has extremely low rating of confidence.

5. Other activities

Recently the groups of experts visited to Russia, France, China, Finland and Bulgaria. They studied the level of nuclear and radiation safety, national nuclear regulatory systems, technical and scientific expertise in the nuclear industry in these countries.

The draft of the Program of education and training of personal for future NPP, regulatory body and other governmental authorities, research and design institutes is developed.

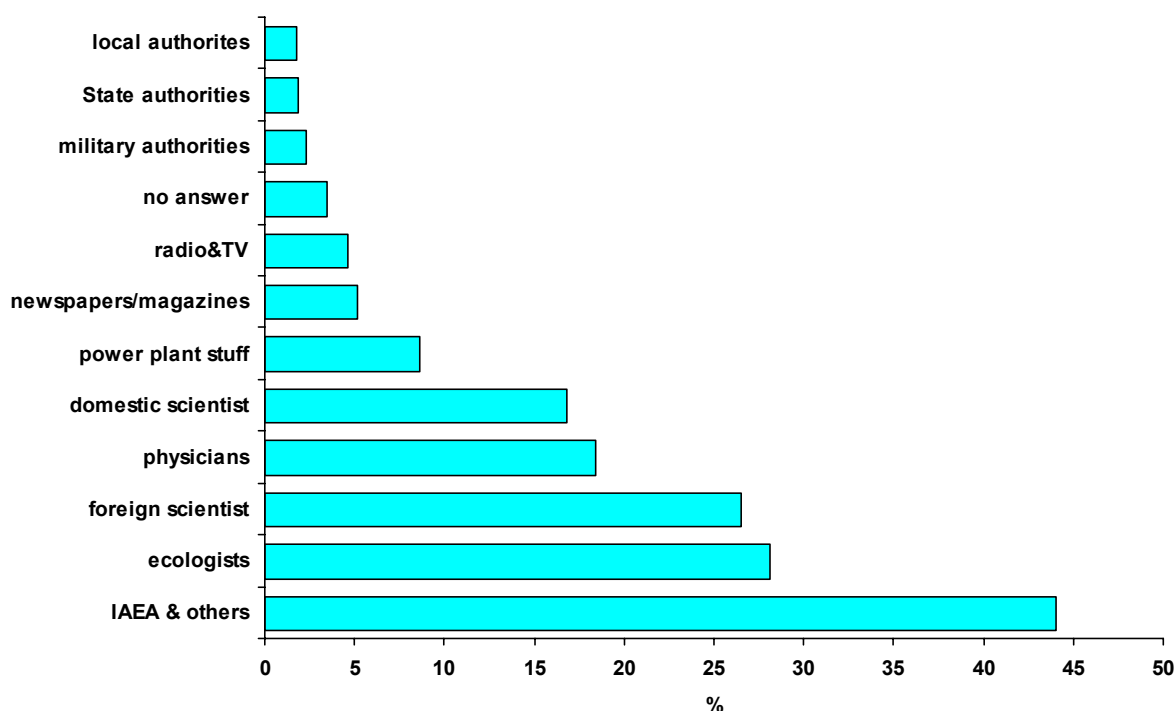


Fig.2. Whose information on NPP performance is trustworthy in Belarus?

TECHNICAL SUPPORT ORGANIZATION OF ARMENIAN NUCLEAR REGULATORY AUTHORITY: ESTABLISHMENT, DEVELOPMENT AND CURRENT STATUS

A. M. Amirjanyan

Nuclear and Radiation Safety Centre of Armenian Nuclear Regulatory Authority
4 Tigran Mets str.,
Yerevan, 0010
Armenia

Abstract. In 1993 the Government of Armenia made a decision to restart Armenian Nuclear Power Plant (ANPP) which was shutdown in 1989. Shortly after that decision Armenian Nuclear Regulatory Authority (ANRA) was established. Absence of local technical support and limited international support created difficulties for new established ANAR during its activities on regulating ANPP modernization process and issuing authorization for restart. Necessity to establish TSO occurred at this stage. By initiative of ANRA a small TSO was established in 2002 with limited staff called Nuclear and Radiation Safety Centre (NRSC). This paper briefly describes the establishment, development and the current activities and problems of NRSC.

1. Introduction

Shutdown of both units of Armenian Nuclear Power Plant (ANPP) in 1989 and breakdown of Soviet Union in 1991 brought to the significant cut-down of funding and closedown of all scientific institutions providing technical support to ANPP. Many specialists in nuclear energy field left Armenia with the purpose to find job outside. Only few of them succeeded in this sense.

In 1993 the Government of Armenia made a decision to restart ANPP. Precondition was to enhance a safety level and continue comprehensive safety upgrading after restart of ANPP Unit 2. The new established ANRA faced difficulties implementing regulatory oversight during ANPP restart activities because of small staff and absence of local technical support. Mainly IAEA and US NRC were providing support to ANRA at the initial stage after establishment of ANRA. Afterwards EU started also to provide ANRA with essential support through TACIS projects. The necessity to establish its own local TSO occurred at this stage. However only in 2002 it was possible to establish a small TSO.

Nuclear and Radiation Safety Centre (NRSC) is the technical support organization of Armenian Nuclear Regulatory Authority (ANRA). It was established in 2002 by the Government of Armenia by initiative of ANRA. NRSC is non governmental organization and not funded by Government. The main mission of NRSC is provision of technical support to ANRA in support of authorization process, emergency response center operation, establishment of regulatory control over radiation sources and information support.

2. Development of Safety analysing capabilities

Initially only 5 specialists were working for the organization. Their competence was in the field of thermal hydraulics modeling and calculations and seismic safety. Many specialists simply refused an invitation to join the company. They have doubts that NRSC will survive.

However NRSC survived and not only: it expanded the field of its activities and made essential steps toward further development.

NRSC developed organizational structure commensurate with the nature of activities it performs. Currently 26 specialists are employed by NRSC. There are many young specialist right after university in NRSC's staff. Two main directions of NRSC are nuclear safety and radiation safety. And two support directions: IT and administrative. The current structure of NRSC is presented on FIG 1.

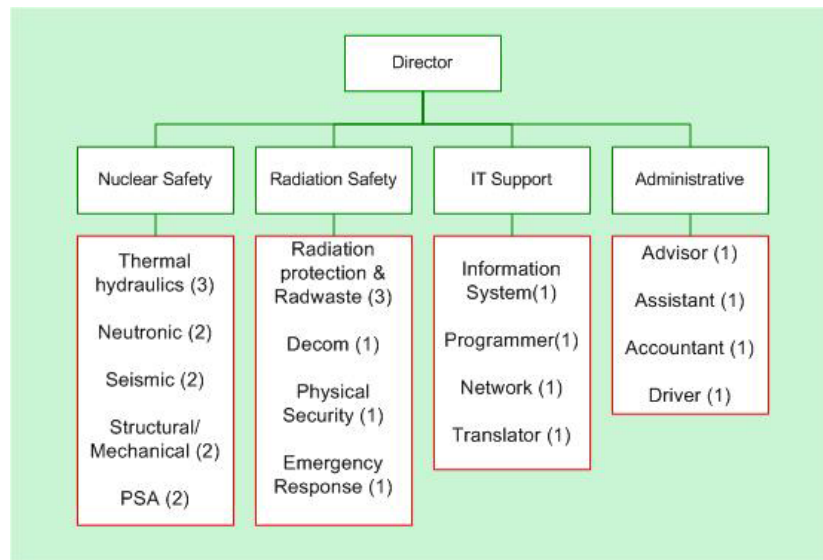


FIG 1. The structure of NRSC

In nuclear safety direction several groups are included: thermal hydraulic, PSA, neutronic, structural/mechanical integrity. In radiation safety direction the following groups are included: radiation safety and protection of sources, decommissioning, physical protection and safeguards and emergency response.

Thermal hydraulic group is using modern safety analysis tools like RELAP and MELCOR for analyzing ANPP safety level. Computational models were developed for analysis of ANPP. Several applications of the developed models are: sensitivity analysis of LOCA 200 mm, analysis of steam line rupture accident for ANPP Unit 2, analysis of primary side feed and bleed operation for ANPP Unit 2.

Seismic safety and structural/mechanical integrity group are also using computational tools for modeling and analyzing of ANPP safety. Particularly the following activities are done: site seismic response analyses taking into account geotechnical uncertainties, floor response spectra generation, soil capacity evaluation, extreme wind and snow impact assessment for ANPP ventilation stack and reactor building roof.

Neutronic group has the following achievements: development of hexagonal model of VVER-440 fuel assemblies for the development of the core model based on PARCS, VVER-440 fuel assembly model development for criticality safety and burn up credit analysis by KENO-VI. The following tools are in the use: OIGEN-S, KENO-VI, PARCS-RELAP, TRITON, SCALE.

Probabilistic safety assessment group actively participated in PSA level 1 study for ANPP Unit 2, internal fire-induced initiating events and external initiating events (excluding seismic-induced initiating events) study.

Radiation safety and protection group together with IT group are providing support to ANRA for establishment of regulatory control over radiation sources, particularly Radiation sources Database were development and data entering is finished, radiation sources Licensing procedures were drafted.

Emergency response group together with t/h group were developed emergency response procedures for operation of the emergency response centre and prognoses of source terms.

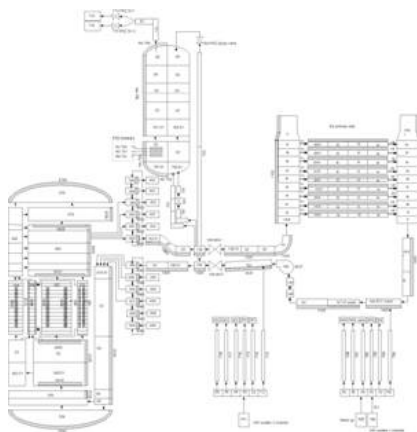


FIG 2. Primary side nodalization scheme of ANPP Unit 2.

ANRA is in the process of establishment of an regulatory information system which includes the following modules: NUCMAD (nuclear materials), RASOD (radiation sources), OCUDOS (occupational doses) and the Technical Library. Of these RASOD has been developed by NRSC. RASOD provides a capability of storing essential information on the radiation sources in Armenia, tracking disposition of the radiation sources and generators over their lifetime, maintaining an accurate inventory, recording any changes, and providing a recoverable history of all transactions.

Reg. No.	Facility Name, City	Sealed Model Name
1227	ՀՀ ՆԱ «Մարտգրգռման փոխարկ կենտրոն» ՓԲԸ, Բաղրամյան-Քյուրյան	DRH27736
1274	ՀՀ ՆԱ «Հռիփսիմյան ատոմային էլեկտրակայան» ՓԲԸ, Մեծամոր	[Unknown]
1273	ՀՀ ՆԱ «Հռիփսիմյան ատոմային էլեկտրակայան» ՓԲԸ, Մեծամոր	[Unknown]
1272	ՀՀ ՆԱ «Հռիփսիմյան ատոմային էլեկտրակայան» ՓԲԸ, Մեծամոր	[Unknown]
1271	ՀՀ ՆԱ «Հռիփսիմյան ատոմային էլեկտրակայան» ՓԲԸ, Մեծամոր	TRH21 - 3
1270	ՀՀ ՆԱ «Հռիփսիմյան ատոմային էլեկտրակայան» ՓԲԸ, Մեծամոր	[Unknown]
1264	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	2179
1263	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	2179
1262	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	2179
1261	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1260	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1259	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1258	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1257	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1256	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1255	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	16
1254	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1253	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1252	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179
1251	Պաշտպանության Ազգային Խառնուրդ, Արարիկ	6179

FIG. 3. One of the pages in RASOD system.

3. Current issues

Relations of NRSC with ANRA are based on annual contracts. Unfortunately at the current stage ANRA has limited funds for contracts and can not cover all its needs. This shortage is covered partially by support projects funded by EU and US NRC. NRSC is involved in the mentioned projects performing particular tasks as a subcontractor of western TSOs. Till now NRSC has worked also for ANPP. This is one of current issues related to NRSC status.

Although the mission statement is the provision of technical support to the regulator however lack of funds that are necessary to maintain the expertise level achieved and development of new expertise capabilities require more funds that are available from ANRA related projects.

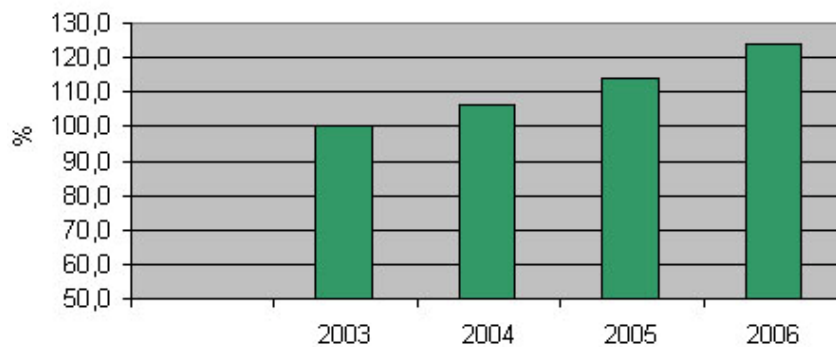


FIG. Annual turnover of NRSC.

NRSC has chosen the strategy of continuous development and is doing its best to go ahead. It is realizable only if qualified specialists are available.

Lack of qualified specialists is the main problem NRSC faces from very beginning of its activities. This is delaying the process of safety analyses capabilities development. In most cases NRSC hasn't any way-out but to prepare specialists by itself. It's a bit of risk for NRSC as preparation of specialists is the process requiring not only time and efforts but also financial sources. NRSC receives no funding for this purpose from ANRA and has to use its own recourses which are limited. This is one area where an international cooperation within a network of TSO's can be very useful. This problem refers not only to preparation of new specialists but also to professional development of existing staff.

Benefits of research activities incorporation into the core business of smaller TSOs

J. Rovny

ÚJD SR

Nuclear Regulatory Authority of the Slovak Republic
Bratislava, Slovak Republic

Abstract. Much has been done to develop the nuclear safety technology to the current level. Nevertheless, incremental development of this knowledge based on demand-pull innovation only seems not to satisfy the future needs of nuclear industry. In order to cope with technical challenges faced by TSOs in the context of nuclear renaissance, the technology-push innovation has to be done in certain amount as well to ensure that brand-new ideas, technologies and attitudes will be implemented in order to enhance nuclear safety. For the reasons described, the technology-push innovation is accessible mainly for larger organizations. In order to cross the entrance barrier for smaller organizations, a cooperation among several TSOs is needed. Uncertainties related to investments in research can be optimized by creating a research project portfolio. According to the traditional innovation management theory, technological innovation is a driver of competition and profitability and, therefore, the motivation is supported by economical benefits.

1. Introduction

The main role of technical support organizations (TSO) in nuclear energy sector is to deliver solutions of problems for utilities, regulatory bodies or other TSOs. This is realized based on traditional customer-supplier relationship, i.e. the customer defines its needs and expected results and the TSO (supplier) creates the product - technical solution based on actual knowledge to satisfy the needs. In order to cope with challenges that the nuclear industry is facing, the knowledge-base upon which the solutions are created has to be seriously developed by basic and applied research. Research, being the only force that has a capability to bring also breakthrough innovations has to be realized to ensure the sustainability of technical support in enhancing nuclear safety.

The aim of this paper is to show the importance of basic research for enhancing nuclear safety and to discuss some of the aspects of traditional innovation management theory with respect to TSOs in nuclear industry.

2. Basic research as a source of nuclear safety enhancement

2.1. *Technology-push vs. demand-pull innovation*

As known from the traditional innovation theory [1], [2], there is a clear difference in the relative significance of generating and sustaining innovation flows when technology-push or demand-pull innovation is involved. Following the demand-pull innovation means that a TSO waits for the customer to come and to order a certain product. The final product is designed based mainly on customer's expectations. As contrary to this, technology-push approach is based on TSO's own ideas,

raised from new innovative technologies, that are offered to potential customers as possible improvements of their performance in any area without any previous demand. While the first attitude usually brings only so-called incremental innovation, the second one can lead to radical innovations - breakthroughs. This phenomenon has been confirmed by many examples throughout the history in all types of industry [3], [4] or [5] and there is no reason to expect that nuclear safety is supposed to be an exception.

In order a certain TSO is able to apply the technology-push innovation, it needs to have the new technology available first, i.e. it needs to have access to new research results. There are two possible ways how to ensure this. Organizations can run their own research activities or simply to outsource research results from other organizations that have their own research program. The more common option used by TSOs is to outsource. This is given by the drawbacks that are related to performing one's own research. The main advantages as well as disadvantages of both options are briefly listed in the following table:

	Advantages	Disadvantages
Own research	- Having the results as the first - Possible profit from potential patents	- Resource intensive - Investing also in unsuccessful projects - Technical and market uncertainty (research project portfolio has to be established [6])
Outsource results	- Paying only for results TSO really needs - No risk involved	- Dependence - Information is available only when it is available for everyone

It follows from the table, that due to high resource intensiveness in combination with larger technical as well as market uncertainty that are always related to the own research option, mainly larger organizations in size can afford doing its own research, while smaller companies have to rely more on outsourcing.

The entrance barrier caused by the resource intensiveness can be overcome by creating cooperation between organizations that joining together are able to create the critical mass of resources to be able to start their own research program. Nevertheless, this possibility is not very widespread among smaller TSOs.

All the circumstances mentioned so far have caused that there is a trend to differentiate between traditional TSOs and between research centers. While the first one are expected to do only demand-pull innovation, almost all the research and subsequent technology-push innovation is expected to be done by large research centers. It is obvious that not every TSO should be involved in basic research, but fostering research activities also among smaller TSOs would bring higher radical innovation flow.

2.2. Research profitability

The question that still remains is the profitability of basic research. Regardless of basic research contribution to nuclear safety, every TSO will decide only on return on investment put into the research. A certain amount of risk, that the results gained will not be of that value as the invested resources, is related to every research activity. The overall risk can be, however, optimized through a portfolio of research projects creation. But in generally, the question of profitability when technology-push approach is involved has been analyzed in the traditional innovation management theory.

According to Schumpeter [7], research brings inventions, that are developed and marketed. Successfully marketed inventions that are introduced to the market bring revenues that exceed investments. The search for new technologies is, therefore, more important than the adaptation to the existing patterns of demand. Simply talking, technological innovation is a driver of competition and profitability.

3. Conclusion

In the perspective of basic research importance as a source of technology-push innovation described, TSOs should be encouraged to perform their own research activities. Moreover, this should not be the privilege of large key players on the market and large research centres only, but, in principal, almost any technical organization, that trough inter-organizational cooperation can start its own research projects, should consider the broadening of its core business portfolio. Incorporating research activities into the core business of smaller TSOs also would lead to increased innovation flow in nuclear safety enhancement. Such decisions are motivated by revenues that are expected to come after the investments in technology-push innovation are done.

REFERENCES

- [1] BURGELMAN, R.A., WHEELWRIGHT, S.C., CHRISTENSEN, C.M., Strategic Management of Technology and Innovation, McGraw-Hill (2002).
- [2] FREEMAN, C., SOETE, L., The economics of Industrial Innovation, 3-rd Edition, MIT Press (1997)
- [3] WATSON, J.D., The double helix, Atheneum, New Yourk (1968).
- [4] SCHERER, F.M., Demand-pull and technological invetion – schmookler revisted, Journal of Industrial Economics, 30(3), p.225-237 (1982).
- [5] VAN LOOY, B., ZIMMERMANN, E., VEUGELERS, R., VERBEEK, A., MELLO, J., DEBACKERE, K., Do science-technology interactions pay off when developing technology?, Scientometrics, Vol. 57, No.3, p. 355-367 (2003).
- [6] MELLO, S., MACKEY, W., LASSER, R., TAIT, R., Value Innovation Portfolio Management: Achieving Double-digit Growth Trough Customer Value, J.Ross Publishing (2006).
- [7] SCHUMPETER, J., The Theory of Economic Development, Harvard Univ. Press, Boston (1934).

Upgrading Nuclear Safety and Security Infrastructure in Yemen

Moustafa Y. Bahran
National Atomic Energy Commission (NATEC)
Sana'a, Republic of Yemen
NATEC1@Y.NET.YE

Abstract:

In 1999 the National Atomic Energy Commission of the Republic of Yemen was established with an emphasis on building Radiation Protection Infrastructure suitable for Yemen and in accordance with international standards. Since then, Yemen arguably has built one of the best such systems in the region if not in the world with respect to the country's needs. This system is going to be upgraded from Radiological Safety and Security system to a Nuclear Safety and Security system. This is to be done as a prerequisite to any further development in the Peaceful Applications of Nuclear Energy, particularly Nuclear Power and Desalination.

1. Introduction:

In 1999 the National Atomic Energy Commission of Yemen (NATEC) was established to undertake both the regulatory and the promotional aspects of the Peaceful Applications of Nuclear Energy. Prior to 1999, zero Radiation Protection Infrastructure existed in Yemen. Since then, Yemen has achieved considerable development in this regard and has become an effective member in the IAEA not just in implementing the IAEA international guides and standards, but also contributing in their development. Recently, the country has expressed the need for Nuclear Power within its sustainable development efforts and to meet its millennium goals. Yemen is going to upgrade its Safety and Security Infrastructure to be suitable for any further development in the Peaceful Application of Nuclear Energy, particularly Nuclear Power and Desalination.

2. Peaceful Application of Atomic Energy in Yemen:

Prior to 1999, only industrial applications in the oil and gas sector existed. After the establishment of NATEC and after establishing its Radiation Protection Infrastructure, Yemen began participating in Peaceful Applications through the IAEA Technical Cooperation programs, in agriculture, medicine, industry, underground water, environment and science. The IAEA Technical Cooperation Report for 2004 (GC(49)/INF/2) listed Yemen among the top countries receiving Technical Cooperation assistance from the IAEA. As an example NATEC has been able to introduce the very first Radiation Oncology service in the history of the country with the help of the IAEA. In the agriculture sector Yemeni specialists involved in an IAEA regional projects have been able to obtain breath taking results in their work. For example they have been able to produce 36 tons of potatoes per hectare compared with a national average of 16 tons per hectare. Not only that, but also with using only 60% of the water usually used by old techniques. A new varieties of Yemeni wheat have been developed with much desired characteristics that resist drought and rust while producing high yield. Many other success stories have been taking place in relevant fields.

Mainly due to the lack of energy resources in Yemen in one hand (diminishing oil production and limited gas reserve) and the existing sever power shortages in the

country (less than one Giga Watt), Yemen has no choice but to consider Nuclear Power both for its major urban needs and for industrial development as well as the growing services sector, in particular tourism. Yemen also is considering utilizing the otherwise normally wasted reactor thermal energy to produce much needed potable water. If Yemen is to utilize Nuclear Energy for power production and water desalination, its Safety and Security Infrastructure must be upgraded to be suitable for such development within international norms and standards.

3. Safety and Security Infrastructure:

In 1993, an IAEA “Peer Review Mission to Evaluate the Effectiveness of the Regulatory Infrastructure in the Republic of Yemen” and to draw “An action plan for the Republic of Yemen” within the “National strategy for improving control over radioactive sources” was carried out. The mission report issued in July of 1993 concluded that *“The regulatory authority in Yemen has been in place since 1999 and has been proactive in seeking to locate, license, and more recently, secure radioactive sources. In particular it has included a requirement in the licensing process for a security plan and this is to be commended as it is in advance of many other countries.”*

In February 2004, an IAEA “International Nuclear Security Advisory service Mission (INSServ)” was carried out in Yemen. The first key conclusion it reported was: *“Yemen is to be commended for its dynamic and proactive approach to radioactive security matters, as was already noted in the (RSRI) Peer Review and the National Strategy reports drawn up by the IAEA in July, 2003. The country’s declared aim is to be regarded as a leader in the Middle East in the field on Nuclear Security”*. The 2nd key conclusion it reported was: *“NATEC is to be commended for having revised the licensing procedure and included in the license application form requirements concerning the appointment of a security officer, and the security categorization of the radioactive sources in questioning in accordance with the IAEA TECDOC 1355.”* The report went on making additional recommendations particularly regarding the training of front line officers (customs, border guards, coast guards, police, ..etc). This was aiming at combating any possible illicit trafficking activities. In February of 2007, the very first training course for front line officers took place in the city off Aden in which 52 high ranking front line officers were trained by IAEA and Yemeni experts. This was done in accordance with the National Nuclear Security Action Plan that has been developed between NATEC and the IAEA. This Action Plan aims at training hundreds of such officers in due time. Also, Yemen in cooperation with the IAEA and donor countries will equip all of its seaports, international airports and land entry points with stationary and/or hand held equipment for monitoring of Nuclear and Other Radioactive Materials. Border patrol units and coast guard units will be equipped with portable equipments. With these developments taking place, Yemen is setting an example in the region and hopefully in the world.

4. Nuclear Safety and Security as a Prerequisite

The main challenge for a Nuclear Power development in Yemen is the Nuclear Safety and Security Infrastructure, yet, NATEC has been very successful so far and in a record time in building one of the most effective Radiological Safety and Security Infrastructure in the region if not the world. About the only criticism the system has received is the issue of independence from the promotional activities. Of course such problem exists in majority of such systems world wide.

Clearly, if Yemen is considering the Nuclear Power and Desalination option, it must first consider separating the Nuclear Regulatory functions from the promotional activities, particularly, Nuclear Power and Desalination. In another words, a Yemeni Nuclear Regulatory Authority must be established independent from Nuclear Energy Applications. One way to do that is by splitting NATEC into 2 entities, one in charge of the Nuclear Regulatory aspects and the other in charge of the Nuclear Peaceful Application aspects. Yemen will not have sever difficulties in establishing a Nuclear Safety and Security Infrastructure since many element of such infrastructure already exist within its successful Radiological Safety and Security Infrastructure. Nevertheless, Yemen will need the help of the IAEA. The IAEA through its very famous Model Project was instrumental in helping Yemen succeed in the Radiological domain. Therefore, The IAEA may want to consider helping Yemen succeed in the Nuclear Safety and Security domain. That can be done through a new Model Project of Upgrading Nuclear Safety and Security Infrastructure in Yemen.

System for TSOs to support NRA decision making

Dr. S. Tzotchev, N. Vlahov M.Sc.

Nuclear Regulatory Agency
Sofia, Bulgaria

Abstract: Bulgaria is a country with limited nuclear programme and is not in a position to establish and maintain a large regulatory authority. The regulatory authority has established its own internal department with the necessary knowledge and capabilities to do safety assessments as well as to review reports submitted by the TSOs. In order to ensure availability of technical support if specific competencies are required or the amount of work is too large, a system of TSOs is established to support the regulatory authority in making regulatory decisions. Avoiding conflict of interests is ensured through framework contracts with the TSOs and their competencies are monitored through a TSOs competence database.

1. Introduction

Nuclear Regulatory Authorities have the responsibilities of development of regulations and guides, review and assessment of safety, authorization, inspection and enforcement. Most of the regulatory authorities also have other functions in respect of emergency preparedness, physical protection or public information. In performing their functions, regulators come out with a series of regulatory decisions in different aspects of safety, which shall be appropriately justified, based on detailed review and assessment or inspections.

To fulfil their functions, regulatory authorities are resourced in a manner corresponding to the activities and facilities they regulate with consideration of the magnitude and nature of the potential hazards. As the nuclear fuel cycle management is a complex of many different in nature activities, requiring technical knowledge and skills in different scientific area it is only within the capabilities of countries with large nuclear programmes to establish national regulatory authority that is entirely self-sufficient in all the technical or functional areas. Some countries with large nuclear programmes establish an independent technical support organisation (TSO) to provide technical competence to the regulatory authority in the required areas (such as Germany, France, etc.)

In general, small countries use open nuclear fuel cycle with main focus on electricity generation from nuclear sources (i.e. operation of NPPs and respective management of generated waste). Those countries establish regulatory authorities that are not very large in size and are self-sufficient in the most important areas of facilities' regulation and control, while seeking advice or assistance from outside experts (TSOs, universities or private consultants) where specific knowledge not available within the organisation is needed.

2. Country situation

Republic of Bulgaria is a country situated in the south-eastern Europe and it occupies the biggest part of the Balkan Peninsula. Bulgaria has six nuclear power units constructed at the Kozloduy site, out of which two WWR-1000 units in operation and four WWR-440 units shut down and in preparation for decommissioning. Additionally, a State Owned Company "Radioactive waste" is operating two waste management facilities to ensure the safe management of RAW generated by the operation of the nuclear power plant and the use of radiation sources in medicine and industry. A decision has been taken by the Government for construction by 2012-2014 of two more 1000 MW nuclear units at the site of Belene (the site was approved by the regulator in Dec 2006).

As a country with limited nuclear programme, Bulgaria is not in a position to establish and maintain a large regulatory authority. The nuclear regulator in the country is the Nuclear Regulatory Agency (NRA), which is an independent authority of the executive power and recently has 108 permanent positions (mostly expert ones) and receives its financing from licensing fees and the state budget. As the national regulatory authority on nuclear safety, radiation protection, spent fuel and RAW management, etc., NRA has the responsibility to review and assess, authorise and inspect all nuclear activities in the country. Even all international review teams visiting Bulgaria for the last few years have unanimously concluded that *“during the last years, the NRA own capabilities of carrying out regulatory reviews and assessments have been significantly increased”*, one of the NRA priorities is the establishment and maintaining of a well structured system for providing the regulator with an independent expert advice on important pre-selected safety issues.

3. NRA system for technical support

The expert knowledge in nuclear issues in the country is concentrated in limited number of organizations, such as national scientific institutes, universities, private companies and of course the operating organizations and the regulator. Additionally, there are individuals that are not part of one of the organizations mentioned above, who have the necessary knowledge and capabilities to make valuable contributions in specific areas of safety concern.

3.1. NRA own review and assessment capabilities

NRA has its own internal department for review and assessment of safety submissions. This department works in close cooperation with the licensing and inspections department as people from both departments take part in the process of review and assessment, depending on the required competencies for the review. Both departments are formed of experienced and skilful staff, most with PhD or Master of Science degree in nuclear engineering, physics, metal sciences, chemistry, etc. Since 2003, the NRA own capabilities of carrying out regulatory reviews and assessments have been significantly increased as 20 new experts and inspectors were employed. In spite of the increased own capacity, the NRA looks for confidence in covering of all areas of nuclear facilities lifecycle.

3.2. Establishing the system for technical support

Starting with the large modernisation and upgrade programs at units 1-4 of the Kozloduy NPP, the NRA started to get overloaded with licensee applications for design modifications. It appeared that NRA did not have, at that time, the required human resources to manage by itself all the submitted safety documentation and even in some specific areas did not have the required knowledge and skills to do the review. This resulted in NRA allocating a lot of efforts and resources, during the last several years, in establishing a well structured, complete and effective system for technical support. The first step of the process included the collection of the necessary information and establishment of a complete database of companies and individuals with competencies in the field of safety of facilities and activities, covering the whole lifecycle of a nuclear installation. This was a complicated task as the large scientific and technical organisation broke and a lot of small and medium size private companies were created during the transition period. Companies' data was collected through filling up a specifically designed by NRA questionnaire, requiring data on company profile, age profile, available competencies, CVs of employees, expert work (contracts) done by the company in the nuclear field, irrespectively for the operator, government authority, third party or internationally, etc. All data was included in a competency database, covering all private TSO's, state scientific and research organizations, universities and individual experts.

Based on the data collected, analyses of companies and own competencies and capabilities and assessment of regulatory challenges in mid-term, in 2003 NRA signed framework contracts for cooperation and expert support with 13 Bulgarian engineering companies and scientific organizations and in 2004 with three more. The main goal of the contracts is to keep the regulator informed about changes in company competencies and capabilities and avoid conflict of interests.

3.3. Maintaining updated information at the database

According to the framework contracts, TSOs shall inform the NRA about any change in their staff composition (hiring new or losing staff, retirements) that may lead to loss of knowledge and skills inside the company or acquiring new areas of professional competence that may be of technical support to the regulator. Additionally, at the beginning of each calendar year the TSOs shall update their company package (explained above), provided as attachment to the contract. Also, TSOs shall inform the NRA about any other information that may be of interest in assigning to them independent reviews related to licensing activities or safety assessments.

3.4. Avoiding conflicts of interest

One of the main objectives of the framework contracts is to avoid conflict of interests. This means that the TSOs working for the NRA shall be effectively independent of the operator or the company working for the operator for the specific task. In general, as most of the TSOs are commercial companies, it is not possible to stop them working for the licensee on different projects. In small countries, with limited number of technically competent organization, all of those companies in different tasks and periods and with different frequency do some work for the operators of nuclear facilities. It is the NRA understanding, that effective independence in this case means “The TSO is not part of the operator structure or a daughter company and did not participated as a company or with experts in the analyses or development of the safety submissions. According to the framework contracts, all TSOs are obliged to inform the NRA on any work they do for operators of nuclear facilities in the country. Additionally, operators should indicate in the safety submissions the companies being involved in the development or review of the documents.

In exceptional cases (SARs, new design), almost all of the local TSOs are involved, so the NRA forms a consortium of the remaining experts with the required competencies and seeks advice from international organizations. The difficulties in those cases are mainly related to assure sufficient financial resources, as the foreign experts are several times more costly than the local ones. In those cases NRA uses the large expert capabilities of the IAEA and tries to finance some of the work on bilateral or multilateral basis. NRA experience in using TSOs shows that one of the future solutions in this respect, especially for small countries is to join the regulatory assessment resources at regional or international level.

4. NRA system to manage external advice

When safety submissions arrive at the NRA, a programme is developed to review and assess the information provided by the licensee/applicant. Within the NRA, the main responsibilities for the review and assessment process lie with the “Department on assessment, analyses and research” (DAAR). Competent experts from other departments may also be included in the process at a later stage. The first stage is to review the completeness of the submitted information. When information is found as incomplete, additional information shall be provided by the licensee/applicant within stipulated time. DAAR performs a comparison analysis of the resources and competences needed to do the review and those available at the NRA, and propose whether external expertise is necessary.

When an external contract is needed, DAAR has the responsibility to develop terms of reference for the contract (shall be approved by the chairman) and based on analyses of the work to be done and required competencies, the TSOs database and the information on the companies involved in documents preparation to propose one or more TSO which to be contracted for the work.

Usually, the final output of the work done under the contract is a detailed written report. Those reports are reviewed by the DAAR and accepted or returned back for additional work. When accepted, reports of TSOs (outside contractors) are evaluated by the DAAR experts, who prepare a proposal how to use the received information and advice provided. Finally, NRA experts' evaluations, with consideration of TSO reports are documented as a safety evaluation report. Based on this report, the NRA chairman takes the regulatory decision. The chairman may also ask for advice the advisory councils on nuclear safety and radiation protection.

NRA bears all the responsibility for making regulatory decisions and has allocated the necessary human and financial resources to secure the effective operations of the system for technical support and ensure:

- full time experts within the regulatory authority who are competent and capable to perform regulatory reviews and assessments;
- full time experts that are trained and capable to evaluate assessments performed by the TSOs;
- availability within the organisation and at the TSOs of necessary assessment tools and computer codes to do the assessment;
- sufficient financial resources to pay for the contracts;
- access to new developments in science and technology to NRA staff and TSOs;
- continuous improvement of own and TSO expertise, through training and education programs, as well as participation in international research and exchange programmes, etc.

5. Advisory Councils

Two advisory bodies are established to the NRA Chairman - Advisory Council on Nuclear Safety and the Advisory Council on Radiation Protection. Members of the Advisory Councils are prominent scientists and experts in the field of nuclear energy and ionizing radiation, radioactive waste management and spent fuel management with recognised professional qualities and experience. These Councils assist the Chairman by giving expert advice on the scientific aspects of nuclear safety and radiation protection, when such advice is asked for.

6. International assessment of the system

The NRA system for technical support has been evaluated and positively assessed by the recent independent reviews (IAEA IRRT and AQG Peer Review missions, conducted in 2003).

7. Conclusions

Countries with limited nuclear programmes do not have the possibilities to establish and maintain a large TSO to work solely for the regulatory authority. In some cases, the NRA needs external independent advice and the selected solution is the use of a system of TSOs that provide expert support to the regulatory authority. This could be one of the solutions for the medium and small countries, which could be supplemented by international cooperation activities on bilateral or multilateral bases.

Place of Technical Support Organizations in Nuclear Energy development

Katia Lubomirova

Nuclear Energy Department
Risk Engineering Ltd.
34, Tottleben Blvd., Sofia 1606, P.O. Box 4
Bulgaria

Abstract. Significant changes in Energy Generation industry and as a consequence in Nuclear Energy put new challenges and extend the tasks that need to be resolved by Technical Support Organisations. Political and economical changes in Bulgaria put also significant influence on Nuclear sector. During the last decade the main challenges for Bulgarian TSO's and for Risk Engineering Ltd in particular came from renovation of nuclear legislative framework, wide modernization programs of Kozloduy NPP Units and decision of Bulgarian Government for construction of Belene NPP.

1. Introduction

During the last decades the changes in the Energy Sector of Bulgaria exercised significant influence upon the Nuclear Power Energy and put a number of new challenges and tasks to the Utilities and the NRA as well as to the Technical Support Organizations for solving. The new Act on Safe Use of Atomic Energy was enacted in 2002 and the Secondary legislation the field of safety was entirely updated, full scope modernization programs were implemented in Kozloduy NPP and the erection of Belene NPP was resumed.

Under such conditions the main tasks of TSO are:

- To provide Expertise and consulting for Nuclear regulatory agency
- To provide Technical assistance, Design and Engineering, for the Utilities

The main services expected from TSO are related to:

1. Construction and commissioning of new nuclear power units:

This task includes development of feasibility studies and technical requirements, conceptual and detail designs, field engineering and technical assistance, quality survey, safety support documentation, procurement engineering.

2. Maintain the high safety level, performance and stable operation of existing nuclear power plants which include technical assistance, engineering support to extend the existing reactors lifetime, periodic safety reassessment analyses and etc.

2. Projects performed by Risk Engineering Ltd for Bulgarian Nuclear Agency¹

In all projects listed under Section 2 Risk Engineering was subcontractor of RISKAUDIT/IRSN/GRS International

2.1. *PHARE Project BG/TS/16 - Assistance to Bulgarian Nuclear regulatory Agency in the Development of Requirements and Procedures for Decommissioning of Kozloduy Units 1 and 2*

The project started October 2002 and finished October 2003. There were three major tasks, namely:

- Assessment of safety-related documentation and other documents submitted by the Applicant, i.e. Kozloduy NPP, with respect to the decommissioning of Units 1 and 2. Among these were Decommissioning Concept, Radiation Protection Concept and others related to facilities envisaged for implementation of decommissioning activities.

Main objective was to bring the International and, more specifically, the European experience in the relevant field by reviewing the above-mentioned documents and providing comments and suggestions to both the Applicant (Kozloduy NPP) and the Beneficiary (Nuclear Regulatory Agency) aiming improvements of the documents and enhancing the regulatory practices.

- Analysis of European and Bulgarian legislative framework with respect to decommissioning;

In June 2002, the new Act on Safe Use of Atomic Energy was enacted. Secondary legislation, i.e. Ordinances, was due in a two-year period. Therefore, the time of project execution coincided with the period of drafting the secondary legislation. The major challenge was that said legislation must be enacted by the Council of Ministers which implies much more complicated and time consuming procedure. The analysis provided grounds for recommendations on the content and scope of secondary legislation. Such were provided to the Beneficiary and, to certain extent, have found their place in particular Ordinances which are now existing.

- Development of draft ordinances on (1) Free-release of radioactive materials and (2) requirements for technical specifications of radioactive waste packages.

Both subjects were new for Bulgarian practise at that time. In the view of decommissioning about to start and expected huge amounts of various materials, the need of procedure and legal base for clearing as much as possible was evident. This need was served by the draft of the first document (presently, there is a section in the Ordinance on Safe Management of Radioactive Waste which is written on the base of our draft). Equally important is radioactive waste management especially when one recalls that this same subject is under development all over the world. In fact, drafting requirements to technical specifications of radioactive waste packages is only a piece of the big picture.

2.2. *PHARE Project BG/TS/15 - Enhancement of Safety Assessment Capabilities of Bulgarian Nuclear Regulatory Agency.*

The project started July 2003 and finished July 2005. There were some 28 measures of the Modernisation Programmes of Units 3, 4, 5 and 6 which were assessed in the frames of this project.

Tasks were divided in four groups: (1) studies related to Units 3 and 4, (2) studies related to Units 5 and 6, (3) configuration changes on Units 3 and 4 and (4) configuration changes on Units 5 and 6.

¹ For all projects listed under Section 2 Risk Engineering Ltd. was subcontractor of RISKAUDIT/IRSN/GRS International

Whenever configuration changes were concerned, judgments were provided on whether these are safety-related and, if such were the case, comments on appropriateness of modifications and recommendations on the licensing conditions were provided to BNRA.

2.3. PHARE Project BG/TS/16 - Assistance to Bulgarian Nuclear regulatory Agency in the Development of Requirements and Procedures for Decommissioning of Kozloduy Units 1 and 2 – follow up

This project is a natural continuation of the one mentioned in item 1 above. There are three major tasks in this project, namely:

- Review of Kozloduy NPP licensing submittals including assessment of safety-related documentation;

This include Safety Analysis Report of the Dry Spent Storage Facility as submitted by Kozloduy NPP asking for construction permit, Technical design of a facility for free release measurements, Installation of a facility for decontaminating pools, tanks of big volumes and cleaning the water, Construction of a facility for treatment of solid waste and spent ion-exchange resins, and Moveable facility for cleaning of liquid radioactive waste;

- Development of regulatory guides on applying decommissioning regulations including development of nine guides as follows: Format and content of PSAR for decommissioning of nuclear reactors, Format and content of PSAR for spent fuel storage facility, for waste treatment facility, for waste disposal facility; Regulatory guide on qualification of waste packages, Regulatory guide on measurement procedures for verification of clearance levels, Regulatory guide on format and content of decommissioning plan, Regulatory guide on format and content of stage decommissioning project, Regulatory guide on format and content of radioactive waste management programme, development of regulatory guide on radiation protection. In addition two more guides were developed, (1) Uniform structure and content of regulatory guides and (2) Format and content of PSAR for waste disposal facility

3. Services provided by Risk Engineering Ltd. for Belene NPP project ²

3.1. Development of Feasibility Study Report for Belene NPP construction

This Report presents the Reactor Options being considered and answers the following questions:

- Does Bulgaria require additional electrical generation capacity?
- Is nuclear a viable generation method if new capacity is needed?
- Is Belene a suitable site for an NPP if nuclear generation is viable?

These Main Conclusions answer the initial questions, namely that Bulgaria will require 1000-2000 MWe of new generation capacity between 2010 and 2014; the Nuclear generation is the preferred viable option for supplying this new capacity and that Belene is the preferred site for installing any new nuclear generation capacity

3.2. Development of Bid Invitation Specification for Belene NPP

- Develop project execution and contracting approach, selecting a best combination of turn-key or split packages approaches.

² Risk Engineering Ltd is subcontractor of Parsons E&C Bulgaria

- Develop the project integrated project schedule for Unit 1, looking for concurrent activities, i.e. doing civil works while completing electro-mechanical design.
- Continue dialog with “interested” Reactor Vendors to gather / confirm technical and economical data, to support decisions
- Financially structure the project allowing best “debt/equity” split
- Define Project organization and define the role of each Island Supplier, inclusive of the Project manager/Owner Engineer
- Further explore possibilities for Power Purchasing Agreements with foreign countries, bringing a major International Utility to the project.

4. Tasks for Project Execution Phase

- Review and recommending approval of vendor provided designs
- Review of designs for compliance to specifications
- Audits & shop inspections
- Coordination of activities between Utility and vendors
- Licensing and Permitting support to owner
- Coordination of Licensing and Permitting activities with vendors
- Specifying and assisting Utility with negotiation of Fuel Supply Contract
- Preparation, Review, and consolidation of Safety Reports utilizing input provided by Candidates
- Completion of As-built walkdowns and final markups for plant drawings
- Assistance to Utility in completing Owner scope of supply

5. Conclusions

That’s way development directions needs to be established for all players in the field, including TSOs which will have an important role to sustain this situation.

For TSO the main task on a long term is to maintain the required competence in a proper safety culture environment, in order to be prepared to assure the proper support for domestic NNP and to be able to join huge and continuous efforts required to support development of safe and competitive nuclear energy.

REFERENCES

- [1] Bid Invitation Specification for Belene Nuclear Power Plant, May 2005
- [2] Feasibility Study for the Construction of the Belene Nuclear Power Plant, BNPP-FS-PEC-NEK-0004-R2-E, December, 2004
- [3] Phare contract 2003/005867.02, Interim Technical Report, September 2006
- [4] Phare contract BG 009.02, Final Technical Report, October 2003
- [5] Phare contract BG/TS/15 (ZZ 9919) Enhancement of safety assessment capabilities of Bulgarian Nuclear Safety Authority, Final report, September 2005

Towards optimal use of available technical resources for regulatory purposes

The Syrian experience

R. Shweikani, H. Suman and I. Othman

Atomic Energy Commission of Syria, Damascus, P. O. Box 6091, Syria

Abstract. The Atomic Energy commission of Syria (AECS) is nominated by Syrian legislation as the regulatory authority in respect of radiation protection and safety and security of radioactive sources. In addition AECS is providing a wide range of Technical Services (TS) through its various departments. In this paper, the cooperation and coordination between the regulatory authority and the providers of technical services in Syria are described. The adjustment of the regulatory programme as to make maximal use of the available technical resources is presented. It was shown that this relationship does not jeopardize the effective independency of the regulatory authority which is maintained by keeping the regulatory decisions based on pure regulatory considerations.

1. Introduction

It is internationally recognized that the national government is responsible for establishing a national infrastructure to ensure adequate level of radiation protection and safety in its country [1]. Essential parts of the national infrastructure are legislations and regulations and the establishment of a regulatory authority empowered to authorize and inspect regulated activities and to enforce the regulatory requirements [2].

The national infrastructure must also provide facilities and services that are essential for radiation protection and safety which are beyond the capabilities of radiation users [2]. Such facilities and services include those needed for intervention, individual dosimetry, environmental monitoring, and calibration of radiation measuring equipment.

In some cases, the available technical services (TS) are not sufficient to completely cope with the country needs. This limitation in the technical services could have an adverse impact on the level of radiation protection. Applying the fundamental principle of optimization of protection and safety implies that the regulatory authority should take this factor in considerations and adjust its regulatory programme as to make optimal use of the available resources country wide.

This article describes the Syrian infrastructure for radiation protection and safety and security of radiation sources with emphasis on the available technical resources in Syria and its effect on the regulatory programme.

2. Syrian Infrastructure

2.1. Legal framework

The Syrian legislation [3] and regulations [4] for the control of ionizing radiation complies with the international standards [1, 2]. Moreover it takes into account the requirements of the code of conduct [5]. It nominates the Atomic Energy Commission of Syria (AECS) as:

- (1) The regulatory authority in respect to radiation protection and safety and security of radiation sources.
- (2) Responsible for emergency planning and coordination for radiological or nuclear accidents

- (3) The competent authority responsible for issuing approval certificates for package design.

On the other hand, AECS is also the major provider of technical services related to ionizing radiation in the country. In order to avoid any potential conflict of interests and to ensure effective independence of the regulatory authority, the Syrian legislation obliges AECS to establish an effectively independent regulatory organ to perform its regulatory functions. AECS should provide this organ with adequate resources including technical ones.

2.2. The regulatory authority

The AECS established in 1998 the Radiological and Nuclear Regulatory Office (RNRO) and delegated its regulatory functions to it. RNRO has been nominated as the regulatory organ specified in the legislation. The RNRO reports directly to the Director General of the AECS and assumes the responsibility of preparing regulations, issuing authorization, performing inspections and enforcing legislations and regulations.

2.3. Technical services

AECS is providing a wide range of TS through its various departments. These TS includes individual dosimetry, calibration, Quality Control of medical radiation generators (QC), analytical services, spectrometry, radiation protection training, etc.

Individual dosimetry is provided by the Radiation Protection Department (RPD). It provides individual dosimetry to about 3500 persons. Around 2800 of them are occupationally exposed. The actual number of occupationally exposed workers in Syria, which need to be monitored according to the Syrian legislation, is 4300. The monitoring is performed using film badges to 85% and TLD to 15%. Basically it is assumed that individual monitoring could satisfactorily respond to the demand of TS in the country.

Calibration is provided through a Secondary Standards Dosimetry Laboratory (SSDL) at RPD. It is capable to provide calibration for X-ray and Gamma radiation in a wide range of energies. Neutron calibration is being established and it is expect to start operating in the next few months. Alpha and beta calibration are not available in Syria.

Quality control of medical radiation generators is provided mainly by RPD. The ministry of health (MoH) provides QC for its generators. The maximum workload of both providers is about 200 generators a year. Taking into account that the operational number of radiation generators is 2800, it becomes obvious that the capability in this sector of TS is by far not sufficient to cover the needs of the country.

Analytical services are available at different departments of AECS. They provide a wide range of measurements related to ionizing radiation using gamma and alpha spectrometry, in addition to many techniques for elements identification for example neutron activation, XRD, XRF....etc. The national needs are met satisfactory.

AECS is the major training provider in the field of radiation protection. It offers training courses and educational programs. Cooperation with other organizations such as the International Atomic Energy Agency (IAEA), the Arab Atomic Energy Agency (AAEA) and national training institutions is maintained. AECS is an IAEA recognized Regional Training Centre (RTC) in radiation protection and safety and security of radiation sources.

Additionally, through its various departments, AECS provides scientific and technical consultations to RNRO as well as radiation users in different fields such as geology, chemistry, civil engineering, etc.

Even though AECS provides a wide range of technical support to radiation users, the capability of timely coverage the country needs is not always ensured due to occasional shortage of resources. As a consequence, AECS may not be able to provide the technical service promptly upon request by radiation users.

3. Interaction between RNRO and Providers of technical services

Direct technical support: Being part of AECS, RNRO can directly benefit from the technical capabilities of AECS. RNRO draws basic technical services from AECS such as:

- Maintenance and calibration of RNRO equipment used for example in inspections (survey meters, contamination meters, etc.)
- Personal dosimetry to RNRO staff members
- Training of RNRO staff members.
- Scientific and technical support as needed.

Procedural harmonization: RNRO and the various providers of technical services within AECS have been seeking harmonization of their procedures in order to ensure the uppermost level of radiation protection available within the available resources, examples:

- Coordination between QC services and RNRO authorization procedures. According to the applicable regulatory system, medical radiation generators need to pass a set of QC tests as a pre-condition for authorization. The authorization procedures and QC procedures have been harmonized in regard to validity, obligation and exemptions.
- Similarly, individual dosimetry of occupationally exposed persons working in controlled areas is a pre-condition of authorization. The authorization procedures take into consideration the capability to cover the needs and allow for a delayed individual monitoring if necessary.

Gradual approach: The enforcement of the regulatory requirements takes into consideration the inability of timely providing TS to all requesting users. Considering the available resources, the regulatory procedures allow for delayed compliance at the radiation users side when the providers of TS are not in position to cover them all. This kind of delay is based on detailed analysis of the existing TS capabilities in Syria and is usually limited for a specific period until the TS providers enhance their capabilities. In particular this was the case in the individual dosimetry. It is still applicable for alpha and beta calibration and quality control of medical radiation generators.

Emergency preparedness and response: AECS is obliged by law to ensure adequate preparedness and response to radiological and nuclear emergencies. RNRO and RPD have been taking harmonized steps to achieve this goal. The resources for emergency response (personnel, equipment, transportation...) are drawn from the technical capability of AECS. Emergency preparedness activities such as planning, communication, training, drill execution is organized and supervised by RNRO.

Information exchange: This is a major field of coordination and cooperation between RNRO and RPD. The information flow is bidirectional: RNRO continuously informs RPD, as a provider of technical services, about the need of services, such as radiation workers dosimetry, QC medical radiation generators and survey-meters calibration. RPD periodically provides RNRO with reports of the services drawn.

Training: As the competence of workers in the field of radiation protection and safety is one of the authorization requirements, AECS provides wide range of training courses and education programme through its departments. RNRO is partially involved in providing such service.

Because many of the TS are being solely provided by AECS, the enforcement of the regulatory requirements has an *un-intentional* and un-avertable side effect of supporting AECS business as provider of TS by pushing radiation users to draw the required services from AECS. Although this side effect does exist, it does not weight in the regulatory decisions making processes. Furthermore, RNRO has been trying to convince private companies to provide TS, such as training and QC, as a lucrative/profitable business.

In summary, RNRO is fully aware of the existing shortage of TS capabilities. Therefore it adjusts its procedures as to achieve maximum use of the available resources and to maintain optimal level of radiation and safety in Syria within the existing conditions

4. Is the effective independence compromised?

The description provided in the previous section on the interaction between RNRO as the regulatory authority and the providers of technical services would raise the questions whether the effective independency of the RNRO is compromised or if there would be some conflict of interests.

The answer is simply NO, because the described interaction does not influence the regulatory decision making process at RNRO side. The described scheme of interaction originated from detailed analysis of what is possible in the country and is absolutely in line with the fundamental principle of optimization in radiation protection.

Moreover, the side effect role of RNRO as a driving force of technical services does not present a conflict of interest, as RNRO has no direct or indirect benefit from the technical services. Its sole intention and behavior is to enforce regulatory requirements. Ultimately, the mutual influence with the providers of TS has no influence on its decisions which are based on pure regulatory considerations.

5. Conclusions

Optimization of radiation and safety, cooperation and coordination are essential key words for the success of the regulatory programme. Proper and careful application in Syria has fruited increase in the level of radiation protection and safety and security of radiation sources, and resulted for an optimal use of available resources without jeopardizing effective independence of the regulatory decisions.

The strict application of the regulatory programme provides a motor force driving the efficient use of technical resources, and helps in minimizing wasting of resources which are already in shortage.

REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, IAEA Safety Standards Series No. GS-R-1, IAEA, Vienna (2000).
- [2] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).
- [3] Syrian Arab Republic, Legislative Decree No. 64 (2005).
- [4] Atomic Energy Commission of Syria, "General Regulations on Protection against Ionizing Radiation", AECS Decision No. 112/99 (1999). Revised regulations have been issued under the Syrian Prime Minister Decree No. 134 (2007).
- [5] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

Enhancing Security at the Mexican Nuclear Research Center

Mario Ballesteros, Hernán Rico

Instituto Nacional de Investigaciones Nucleares
La Marquesa, Estado de Mexico
Mexico

Abstract. Enhancing security is always a requirement to meet in any nuclear facility. For a nuclear facility, it will help to reduce or to eliminate any possible consequence under a likely terrorist attack. In Mexican nuclear facilities security is a priority and several steps have been done in this regard. As an example, the current paper shows the implementation of enhancing security at the Mexican Nuclear Research Center.

1. Introduction

As in every part of the world, 11-S events caused some concerns on the Physical Protection and Security (PPS) of sensitive facilities in the country. Particular, nuclear facilities are a very sensitive item, although they already account with many physical protection and security, they still can improve and enhance these measurements.

National security entities required deep reviewings of PPS systems addressed to identify vulnerabilities to severe terrorist attacks

The National Institute of Nuclear Research (ININ, as its acronym in Spanish), as one of the sensitive facilities in the country, had since its very beginning, a well implemented Physical Protection and Security Plan (ININ-PPS). However, enhancing security is always a goal to achieve, therefore, the implementation of a special program to identify those items that were necessary to improve in order to strength the ININ-PPSP is an opportunity to enhance the research center security.

On the other hand, Physical Protection and Security is just a field of Nuclear Safety, so the experience gained by ININ in this important task, may be worthy for others Technical and Scientific Support Organizations.

2. The Mexican Nuclear Research Center

ININ is located 36 km away in the North East outskirts of Mexico City. Laboring population is about 750 people, composed of scientists, technologists and administrative and supportive personnel. Activities are mainly devoted to research and development (R+D) in nuclear and associated fields, but also some services are offered to industry and hospitals.

A number of well equipped laboratories are housed on site. There are also several radioactive and nuclear facilities that in conjunction bring the necessity to have well established physical protection and security measures. The two main radioactive facilities are the Plant for the Production of radiofarmaceuticals, where Iodine-131, Technecium-99, and some others radiosiotopes are dissolved in kits to be distributed among hospitals for nuclear medicine

purposes; and the industrial irradiation Plant where disposable medical products, dry food products, cosmetics and others items are sterilized by means of intensive fields of radiation through the exposure to 700,000 curies of Cobalt-60.

On the other hand, the Triga Mark III reactor is the main nuclear facility on site. Manufactured by General Atomics, it has been operating since 1968 for research and isotope production purposes. It is a 1 MWth reactor which operates on demand (about 1400 hs per year). Due to the existence of irradiated nuclear fuel, the reactor is considered the target facility for PPS planning and preparedness purposes (Fig. 1).



Fig. 1. Mexican Triga Mark III Reactor

3. Physical Protection and Security

The ININ-PPS plan is an auditable document which contains the items on Organization, Procedures, Facilities, Equipment, Training, Exercises and Drills, that have to be maintained operative in order to assure the physical protection and security of the institute facilities.

The ININ-PPS organization is headed by a PPS coordinator which is responsible of the preparedness and performing of the plan. This post has a direct organizational communication with the General Director of the institute, assuring in this manner that every issue relevant to PPS purposes will be attended and solved in an expedite way. As shown in Figure 2, there are three PPS operative groups. There is one third party team which provides PPS services under contract from and external company. There is also an army company which has its headquarters on site. And there is an internal group with personnel belonging to the institute itself.

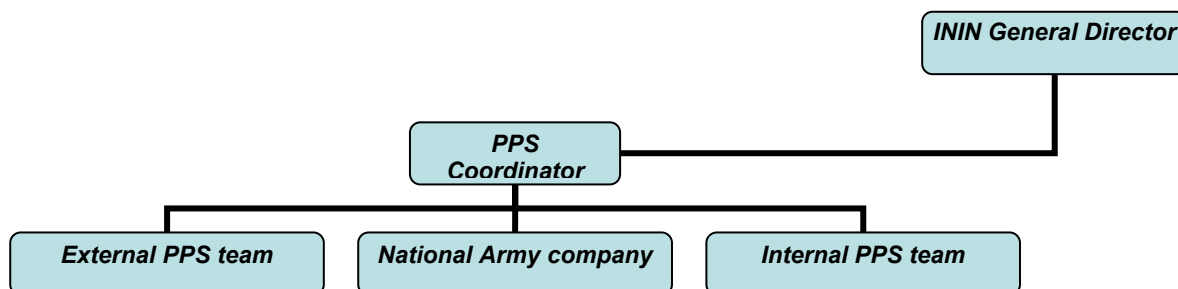


Fig. 2.- ININ-PPS Plan Organization

These groups are devoted to the basic activities of security and surveillance, however under certain circumstances there is an augmented organization with personnel from others areas of the institute.

The plan comprises several procedures which cover the main tasks that are implemented such as: access control, intrusion prevention, surveillance of restricted areas, sensitive facilities, loss prevention, detection of suspicious activities, activation of intervention in case of abnormal situation, and documentation of incidents and events.

4. Enhancing Security

A program has been established to improve the security at the Mexican Nuclear Research Center. Among the tasks in this program is the identification of weak security points and to carry out security systems upgrades. The latter is a task that is still going at ININ due chiefly to budgetary constrains.

A number of resources have been dedicated exclusively to ININ-PPS activities. It can be mentioned for instance, radiation portals at institute main entrance and exit, with capacity to detect transit of radioactive and nuclear materials by vehicles, from or in to the institute; surveillance tower-type posts for army personnel in strategic areas; closed circuit TV network in sensitive facilities; radio communication equipment; and dedicated vehicles.

A special training program has been implemented for ININ-PPS teams, divided according to their specifics tasks. Training is complemented through drills simulating hypothetic PPS events, and every thing is tested by conducting integrated scale exercises on a regular basis at least once pear year. A feed-backing to the plan is made from the recorded findings.

All of these activities are umpired by the National Commission of Nuclear Safety and Safeguards (CNSNS as its acronym in Spanish), as the regulatory authority in nuclear matters. The proposed Design Base Thread (DBT) of ININ-PPS plan shall be agreed with CNSNS, which is one of the tasks still pending; concerning this issue, in the meanwhile for preparedness purposes, standard reference DBTs are being used. There is also a project in

agreement with the USDOE to install an Central Alarm Station and upgrade some other issues.

REFERENCES

- [1] Plan de Seguridad Física del ININ.
- [2] INFCIRC/225Rev.4 (Corrected) The Physical Protection of Nuclear Material and Nuclear Facilities.
- [3] TM 29607 Working Paper. No. 3 Rev4

Radiation Protection and the Role of TSOs in Kenya

Maina, Joseph A.W.
Radiation Protection Board
National Radiation Protection Laboratory
Kenyatta National Hospital Grounds
Hospital Road
P.O. Box 19841-00202
Nairobi – Kenya

Abstract

Since the late '60s and through the early '90s Kenya has always recognized and appreciated the need for support from Technical and Scientific Support Organizations (TSOs) for activities geared towards enhancing nuclear and radiation safety.

The TSOs have since then gained increasing importance for provision of technical and scientific basis for policy formulation, implementation and legislation with regard to radiation safety.

National and specific operator programmes on safety and security of radiation source and radioactive waste recognize and encourage the active participation of TSOs. Due to the role they play, technical competence, transparency and the observance of ethical practices have become essential both for the regulator and the regulated.

In this respect, interaction and cooperation between stake holders (regulatory authorities, users of radiation, generators of radioactive waste, professional organizations) and TSOs, in the frame of national and regional networks as well as in ad hoc frameworks, have been fostered.

1.0 Introduction

Though Kenya became a member state of the IAEA in 1965, it was not until 1982 that legislation on regulating use of radiation sources was enacted by the Country's parliament. Subsequent subsidiary legislations were enacted in 1986 and formal establishment of the Regulatory Authority – Radiation Protection Board (the Board) – followed later that same year.

The use of radiation based technology in Kenya has experienced tremendous growth since the first radiotherapy department in black Africa was set up at the then King George Hospital in 1968, courtesy of the Swedish Government through the Karolinska Institute in Sweden. The period 1968 through the mid '70s saw rapid growth on the use of radioisotopes in medicine and other radiological services throughout the country.

This marked the beginning of the contribution of the technical and scientific support organizations to Kenya to facilitate the development of a legislative framework and a regulatory infrastructure for radiation protection. Such technical and scientific support

helped to set up personal radiation monitoring services, quality assurance programmes for radiological equipment and other radiation protection services.

The support also laid the foundation for regulatory legislation which culminated in the enactment of the Radiation Protection Act by parliament in 1982, establishment and operationalization of the Regulatory Authority (the Board) in late 1986.

With the Chernobyl nuclear power plant accident in 1986, there came an international growing demand for monitoring radioactivity levels in foodstuffs and other consumer and environmental products, and particularly those in cross-border trade.

Again, the Board received technical and scientific support in the early 1990s by way of radioactivity detection and measurement equipment as well as training in radioanalytical techniques and environmental monitoring.

Illicit trafficking of radioactive and nuclear materials constitutes a major challenge to the Board. It is only through fostering partnerships with TSOs for provision of additional technical and scientific support that this menace may be combated, if not eliminated.

The Board, therefore recognizes and appreciates the role played by Technical and Scientific Support Organizations in promoting effective regulation and contributing towards enhancing radiation health and safety.

The Board continues to enjoy support from various TSOs and usually makes available substantial financial resources for radiation safety programmes coordinated by various the TSOs in the field of nuclear, radiation and waste safety.

2.0 The different types of TSOs in Kenya

TSOs in Kenya provide scientific, technical and other assistance to various radiation safety programmes focused on:

(a) Operator(s)

- radiation facility design safety mainly in medical, industrial and research facilities
- operational safety for the facilities
- emergency preparedness and response
- radioactive waste management for radioactive waste generators
- decommissioning radiation facilities and practices (including partial decommissioning)
- provision of radiation safety services – these include undertaking quality assurance programmes, personal dosimetry services, radioanalytical services, calibration services and maintenance and repair.

(b) Regulatory Authorities

- strengthening human and technical resource capacity and expertise through training
- performing intercomparison exercises
- undertaking joint research projects
- objectively disseminating information into the realm of public awareness.

(c) professional organizations

- to deal with professional ethics and provide technical and scientific basis for decisions and activities regarding nuclear and radiation safety.
- perform independent research

In providing the vital support for the technical and scientific basis for decision making, TSOs are reminded to ensure that the Regulatory Authority maintains the primary responsibility for authorizations and regular auditing while the operator(s) maintains the primary responsibility for the safe operation of their radiation facilities and adopts appropriate technical and scientific solutions that may be required to maintain safety and security standards to required levels.

3.0. Role of TSOs in enhancing nuclear and radiation safety

Several TSOs in Kenya have supported the authorization process through participation in the formulation of regulations and Quality Assurance Programmes. The TSOs have also undertaken development of comprehensive guidelines, facility inspections with attendant technical and scientific QA tests with recommendations to the regulatory authority on areas requiring enforcement.

TSOs in Kenya have also sounded an alarm on the operational safety for certain low-cost radiological facilities. This has culminated in a stakeholders meeting where the same TSOs provide independent scientific advice for consideration on way forward. This serves as an early warning to regulators and operators of radiation facilities on potential safety issues that need to be addressed at the earliest opportunity or require immediate intervention.

With the ever expanding and diverse application of radiation based technology, no regulatory authority - especially in developing countries - can boast of adequacy in technical and human resource capability far from it.

TSOs therefore offer the technical and scientific knowledge base from which regulatory authorities may tap for specific tasks – expert consultancy services. Such expertise also provides continuous monitoring, assessment, research and development in various aspects of the nuclear and radiation safety programmes.

Though emergency preparedness and response has not firmly taken root in radiation facilities, efforts are being made, through training and with the support of TSOs to ensure this aspect of safety is incorporated in the operational management of all radiation facilities.

TSOs play an important role in human resource development, objective information dissemination to the public and participation in public debates on contemporary nuclear and radiation safety issues. This role of TSOs encourages openness, enhances transparency and builds public confidence.

4.0. Value Benefits of TSOs

TSOs act as buffers, especially between regulators on the one hand and operators and the public on the other. They provide independent advice and informed professional opinion based on sound technical and scientific research. This forms the basis for decision making and builds stakeholder confidence. Due to the wide range of expertise in the TSOs, and their moderate approach to nuclear and radiation safety issues, public concerns are reassured.

The benefits however, are not without challenges. Political and economic factors, negative public perceptions, external clearance on use of some radiation technology are some of the challenges hampering effective support of the TSOs.

References

1. Act, Radiation Protection Act, Cap. 243, Laws of Kenya (1982). Government Printer, Nairobi.
2. Strategic Plan (2006). Radiation Protection Board. Nairobi, Kenya (unpublished).

Serving the Industry to Improve Nuclear Power

Operational Performance

By Mr.Li Songbai, Vice President, Ms.Cheng Jianxiu, Director of Assessment Centre,
Research Institute of Nuclear Power Operation

Abstract:

The mission, work scope, practices and experiences of a technical and scientific support organization to Chinese industry are described, and some challenges are discussed and finally, some recommendations are proposed to resolve these problems face by TSO.

1 Introduction

Research Institute of Nuclear Power Operation (RINPO), founded by China government in 1982 while China started to develop nuclear power plant in Qinshan, is a typical and important technical and scientific support organization (TSO) to the nuclear industry, whose mission is to *“provide technical support and service to the industry for assurance of safe, reliable and economical operation of nuclear power”*.

The technical and scientific supports to the industry provided by RINPO consist of two parts, one is to China nuclear power industry administration government, China Atomic Energy Authority (CAEA), and the other is to the Nuclear Power plants.

2 Technical and Scientific Support to the Industry Administration

2.1 Nuclear Power Operation Assessments

RINPO, becoming and being China INPO, provides technical support to China Nuclear Power Operational Assessment Committee, to co-organize comprehensive peer review and assessment, specific peer review and assessment to Chinese nuclear power plants periodically in accordance with the planning and schedule adopted by the Committee. The first peer review was conducted for Qinshan Phase 2 in 2004, and has achieved excellent result because the peer review team members came from China nuclear power plants, who have experience of peer review, understand Chinese culture and speak home language. Last year, a joint peer review with WANO-PC was performed for Daya Bay Nuclear Power Plant in March 2006. And a specific peer review focusing on training was performed for Qinshan phase 1 last August.

2.2 Operational Experience Feedback for Chinese Nuclear Power

Operational Experience (OE) feedback for Chinese nuclear power is to collect and analyze the operational experiences from operational Chinese nuclear power plants and other nuclear power plants through IAEA, WANO and the Industry, and

feedback to Chinese nuclear power plants for their reference. An intranet “China Information Network for Nuclear Operation” (CINNO) has been set up in RINPO and been sharing for Chinese nuclear power plants and relevant engineering/designing organizations. On the other hand, OE documentation and information including “China Nuclear Power Operation Annual Report”, “Production Quarterly Report of Operational Nuclear Power Plants”, and “Operational Experience Feedback Report” have been issued periodically by RINPO in cooperation with the owners and the industry.

2.3 License Examination of Reactor Operators and Senior Operators.

According to the regulatory requirements, China Standard specification and the nuclear power type, RINPO compiles test questions for reactor operator and senior operator’s examination, each examination only be applicable to the typical plant, such as the test for Qinshan phase 2 is different from that of DNMC, because the plant systems and specifications are different between them although they are PWR reactor. Now RINPO is investigating and studying the necessity and possibility to conduct additional the psychological test for the reactor operator candidates.

2.4 Technical support to CAEA for INES and IRS of IAEA, and WANO

RINPO provides technical and scientific support to World Association of Nuclear Operators (WANO-TC), to CAEA for INES and IRS of IAEA, and to CAEA for Asian Nuclear Safety Network in operation and training.

2.5 Technical Support for NPP Operational Emergency

On the basis of our desktop simulators of all NPPs in China and analytical simulator, and engineering expertise, RINPO provides technical support for NPP operational emergency.

2.6 Compiling “China National Report under the Convention of Nuclear Safety”.

RINPO provides technical and scientific support to NNSA in some area such as compiling “National Report under the Convention on Nuclear Safety” and participating in the discussion and clarification thereof among the State members.

3 Technical and Scientific Support to the Nuclear Power Plants

3.1 Engineering, Maintenance and Modification

Engineering and experiment are the basis and foundation for any technical and scientific support activities. RINPO performs engineering and experiment for the key components of nuclear power plants, such as Steam Generators and pressure retaining vessel to accumulate experience and knowledge. On the basis of these researches, RINPO provides technical and scientific support to the NPPs for the key equipment maintenance & modification and lifetime assessment. For example, an integrated solution for Steam Generator, which covers SG R&D, M&R during

operation and ageing and life management, provides an all-around lifetime technique support for NPP. Now, RINPO is assisting QNPC and TQNPC to implement SG ageing management.

RINPO also designs and manufactures special maintenance tools for the NPPs such as Underwater Vacuum Cleaner, Television Inspection Tools, Creeper Manhole Seating, and Plug Special Handle Tool for Thimble Plug Assembly, etc to improve the reliability and efficiency of maintenance activities during outage.

3.2 In-service Inspection

The purpose of in-service inspection is to find out changes of material properties even growth of flaws, which arise from the components being exposed to influence such as stress, temperature, irradiation, hydrogen absorption, corrosive attack and fretting. So the pre-service inspection (PSI) and in-service inspection (ISI) are very important to the safe operation of nuclear power plant.

RINPO develop the art of state technology of PSI and ISI to improve reliability and accuracy of the inspection, and perform PSI and ISI for Chinese nuclear power plants using the validated technologies, competent engineers and approved procedures. RINPO also conducts the diagnostics for the valves during outage.

The indication or defects found during the inspection or test shall be assessed and evaluated if they are excess to acceptable criteria stipulated in the Code and procedures.

3.3 Training and Qualification

Many kinds of training methods and components have been developed by RINPO to improve the capability of relevant persons. RINPO develop or upgrade different simulators to be used for different involvers, such as full scope simulators for reactor operator or senior operator training, multifunctional simulators to senior managers training, principle simulators for middle class engineers training, and analytical simulators for regulatory engineers and safety engineer training. RINPO develop virtual reality (VR) technology based training systems, including refueling simulator, assembly and maintenance system, Valve and Weld Locating System, Nuclear Island Equipment Searching VR System, DCS Simulation Technology, and Design V&V Environment for the training operator, maintenance engineers and technician and contractors. RINPO design and manufacture many Mock-ups such as reactor pressure vessel, steam generator, pressurizer, and fuel assemble for training.

3.4 Operational Management Software

The tailor made operational management software could improve not only the safety of the plant operation, but also the efficiency and performance of the plant operation. RINPO develop different operational management software for the NPPs, such as Work-permit Management System (WMS), Chemical Data Management System (CDMS), Operational Experience Management System (OEMS), Training Management System based on Systematic Approach to Training (TMS-SAT) and

etc.

3.5 Quality Assurance Consultants and Technical Support

RINPO provides QA consultation and training for nuclear suppliers of China including construction, commissioning and operation in NPP, scoped with IAEA, HAF and ISO relevant code or guideline. Now, they are studying the transition from QA based management system to Integrated one.

4 Challenges and Recommendations

4.1 Challenges Faced by TSO

a) Different Kind of Reactors Need Difference Technologies to Support

One of the main challenges faced by Chinese TSO including RINPO is that the operating nuclear power plants equip different reactor, for example, for Qinshan 1 with one unit Chinese 300MW PWR, Qinshan 2 with 2 units Chinese 600MW PWR, Qinshan 3 with two units 728MW CANDU reactor, and Daya Bay with 4 units 900 plus PWR, but for Tianwan with 2 units 1000MW VVER. It's meant that the TSOs in China need more knowledge and experts to provide supports to meet the regulator and industry requirements.

b) Stronger Market Competition May Result in TSOs' Support Ineffectively

China is planning to build more than 30 units nuclear power with 1000 MW each by 2020, which need more competent experts to provide technical supports. High development of nuclear power induces more opportunities for TSOs and also may result in stronger competition between them. So, another challenge is that increasing competition among TSOs arisen from rapid development of nuclear power in China may result in insufficiency of competent technical and scientific experts and lower quality of the support. The competition between TSOs is necessary, but excessive competition may decrease the objectivity, equity and accuracy of TSOs' evaluation, make TSOs appropriate and reasonable financial resources to be reduced, their ability of continuous research and improvement to be weakened, and also result in resource waste, such as repeat construction of research facilities, repeat research in the same areas, etc. This situation would finally do harm to the benefit of all the concerned parties.

c) New Nuclear Power Technology requires New Technology to Support

China is constructing LingAo phase two project, Hongyanhe project with 900 MW PWR technology and Qinshan phase two unit 3 & 4 with 600 MW PWR. And China is planning to build more nuclear powers with the third generation technology such as AP1000, or/and EPR1400 recently. The new generation nuclear power will need the TSO to develop new technology providing support for the regulator and the industry.

4.2 Recommendations and Suggestion

a) Enhancing Training to TSO Participants

Training, not only in class, but also on the job is essential to improve the knowledge, skill and ability of the TSOs' participants. Advanced training facilities and measures

shall be developed and used, such as Mock-up, virtual reality simulator, and plant tour during outage. And IAEA should develop its programme to assist TSOs of Member States in human resource development by organizing training courses at international, regional, sub-regional and national level.

b) Enhancing communication between TSOs and Stakeholders

Communication shall be enhanced among the licensee, regulatory, industry, owner and TSO to make them share the information and understand the requirements and actions. More opportunity should be provided for the TSO to meet together, sharing good practice and resources, and exchanging technical knowledge and experiences.

c) Enhancing Cooperation among TSOs and Stakeholders

The TSO shall establish long term, stable, honest and mutual beneficial relationship with the industry, the owners they service, and the regulators to improve the safety and reliability of nuclear power operation. And TSO for regulator and TSO for industry should work together in developing common research work on nuclear and radiation safety, though the function of TSO for regulator and TSO for industry may be not same, In addition, International cooperation should pay more attention to the countries with emerging nuclear programme to ensure that a high level of safety is achieved.

d) Enhancing the Sharing TSOs' Resources

It is suggested that the TSOs' resources should be shared between regulators and industry/operators so that a better way could be found to make TSOs more functional, cooperative and effective. The regulator can share the equipment, technology and human resource from the TSO for the industry, and vice versa.

e) Enhancing TSO Involvement in IAEA Standard and Guideline

IAEA standards and guideline are now extremely valuable to guide national regulatory activities, However, IAEA standard and guideline need to be continually updated to reflect new developments, especially that of nuclear emerging country such as China. TSOs should be more involved in this process and make more contribution in the developing of new IAEA standards and guideline. However, at present, only a few TSOs are involved in the development of IAEA safety standards and guideline.

f) Establishing TSO International Regular Conference

It is suggested that some international conference like this conference should be organized regularly by IAEA in order to help and guide the activities of TSO in the member States.

5 Conclusions

The booming of China nuclear power development would bring more opportunities to the TSO for regulator and TSO for industry, and also result in more challenges thereto. Effective measures should be taken to resolve these problems and to improve the knowledge, skill and capability of the TSO to assure the safety and performance of nuclear power operation.



ITALIAN MILITARY RESPONSE TO NUCLEAR SAFETY

S.Ten. Alessia MUGNAI POGGESI

**Carabinieri Environmental Care Command
Pollution From Radioactive Substance Section
Rome, Italy**

Abstract: The “Carabinieri Force for Environment Protection” is a specialized Command of Carabinieri Corps. Our duties are vigilance, prevention and repression of all violation relating the Environment. Tasks of the Unit are: the environmental and the landscaping protection; ground, water, air and acoustic pollution; use of dangerous substances and risk of industrial activities; plants and animals protection; electromagnetic and radioactive pollution; G.M.O. (Genetically Modified Organisms).

1. INTRODUCTION: HOW IS ORGANIZED CARABINIERI FORCE FOR THE ENVIRONMENT

The Command (C.C.T.A.) is organized in **3 groups** (North, Centre and South of Italy) including **29 environmental operative teams** (N.O.E.) and, with national competences, there is **Analysis Unit**, for criminal events control and statistical studies in the environmental field, and **Operative Unit**, including 3 sections: **Operative Central Section** (S.O.C.) for investigation over illicit traffic of waste and organized criminality in the same field; **Air Pollution and Risk Industries Section** (I.A.R.), to prevent chemical pollution and disasters; **“Radioactive Material Pollution Section”** (called RAD Section).

2. POLLUTION FROM RADIOACTIVE SUBSTANCE SECTION'S COMPETENCES

It was born in 1996 with the aim to contrast and prevent environmental violation inside its particular sector, including **illicit traffic on nuclear material, the other radioactive sources and radioactive waste**.

Tutta l'attività della sezione è finalizzata a prevenire l'uso scorretto di questi materiali, che potrebbero causare danni alle persone e all'ambiente, ed è riassumibile in:

- il contrasto alle crescenti forme di illegalità in materia di traffico e smaltimento illecito di materiale nucleare e rifiuti radioattivi;
- la prevenzione e la repressione dei reati connessi all'utilizzo delle radiazioni ionizzanti;
- le attività investigativi e di controllo sull'impiego di radioisotopi e radiazioni ionizzanti in ambito industriale, medico e di ricerca;
- il controllo e verifica degli impianti nucleari in “decommissioning”;
- le attività di ricerca delle c.d. “sorgenti orfane”;
- attività connesse al mantenimento di un elevato livello di sicurezza nucleare (*safety e security*)

La competenza specifica del Reparto, in questo particolare ambito d'intervento, è stata riconosciuta anche in sede di cooperazione Europol sulla base delle direttive emanate dal Consiglio Generale per la lotta alla criminalità organizzata (gennaio 1992).

Conseguentemente, costituisce interlocutore privilegiato di Interpol & Europol, in materia di traffico illecito di sostanze radioattive. Nell'ambito del "programma di prevenzione e lotta al traffico illecito di materiale nucleare" (G8 /N.P.E.G.), assolve le funzioni di "Punto di Contatto Interno". Gestisce, così, il flusso d'informazioni provenienti da tutte le altre FF.PP. e dagli Organismi nazionali di intelligence, trasmettendo le segnalazioni, attraverso il Punto di Contatto Esterno, istituito presso il Ministero degli Affari Esteri, alle paritetiche strutture dei Paesi del G8.

In ambito nazionale la Sezione Inquinamento da Sostanze Radioattive ha stabilito importanti sinergie operative e protocolli di collaborazione con l'A.P.A.T. (Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici), l'E.N.E.A. (Ente per le Nuove tecnologie, l'Energia e l'Ambiente), l'Istituto Nazionale di Geofisica e Vulcanologia - Laboratorio di Geofisica Ambientale, l'I.S.S. (Istituto Superiore di Sanità), le strutture regionali e locali per il controllo della radioattività (C.R.R.- A.S.L.- A.R.P.A.), l'Agenzia delle Dogane, l'I.S.P.E.S.L. (Istituto Superiore di Prevenzione e Sicurezza del Lavoro), il C.I.S.A.M. (Centro Interforze Studi e Applicazioni Militari), il Corpo Nazionale Vigili del Fuoco – Laboratorio di Difesa Atomica, la Scuola Interforze per la Difesa Nucleare, Biologica e Chimica ed il 7° Rgt. NBC "Cremona".

3. ATTIVITA' OPERATIVA

Nel quadro delle proprie attività istituzionali, sono state condotte, e sono tutt'ora in atto, diverse campagne volte a monitorare la situazione delle materie nucleari e delle sostanze radioattive sul territorio nazionale ed in particolare:

- valutazione delle condizioni di sicurezza passiva delle strutture destinate allo stoccaggio dei materiali nucleari e dei rifiuti radioattivi, onde prevenirne un uso illecito;
- svolgimento di una indagine conoscitiva sul rinvenimento di sorgenti orfane all'interno di carichi di rottami metallici destinati alle acciaierie;
- settembre 2005, operazione "PROTECT", condotta e coordinata, a livello europeo, dall'Agenzia delle Dogane in collaborazione con i VV.F. e la Guardia di Finanza, finalizzata a "testare" l'efficacia ed a migliorare la capacità di intercettare merci e materiali N.B.C.R. in ingresso sul territorio Europeo e destinati ad un impiego illecito;
- è in fase conclusiva una attività in collaborazione con I.S.S. volta alla ricerca e messa in sicurezza dei preparati di radio 226 e di cobalto 60 altamente radioattivi, utilizzati fino a qualche anno fa in campo medico e di cui si sono in parte perse le tracce, onde verificarne le modalità di detenzione da parte delle strutture sanitarie od il loro corretto eventuale smaltimento;

Da quanto finora emerso dalle suddette attività, si è potuto constatare che la metodologia più comune di smaltimento illegale di materiale radioattivo consiste nell'abbandono di vecchie sorgenti ancora attive ma inutilizzabili ai fini diagnostici o industriali. Si sono evidenziate, talvolta, irregolarità di svolgimento delle pratiche di radiografie e/o gammagrafie industriali. Un altro problema delicato e con possibili implicazioni radiologiche è costituito indirettamente dalle acciaierie che acquistano e riciclano regolarmente carichi di rottami metallici per un fabbisogno totale di oltre venti milioni di tonnellate annue, destinati ai loro forni, di cui circa sette milioni di tonnellate sono di importazione. Talvolta, infatti, in questi carichi si sono rinvenute le cosiddette "sorgenti orfane", ovvero sorgenti radioattive che in seguito a perdita, furto o abbandono, sono fuori

da ogni controllo ufficiale. Queste sorgenti, se tempestivamente identificate, con gli appositi portali di rilevamento della radioattività, vengono messe in sicurezza e rimandate ai paesi d'origine, ma in talune situazioni in cui le sorgenti sono debitamente schermate possono risultare impossibili da individuare se non dopo la loro fusione, con conseguenze critiche per l'ambiente e per l'industria stessa che si trova a dover fronteggiare problemi di natura sanitaria del personale e delle popolazioni circostanti, nonché di messa in sicurezza e bonifica degli interi impianti, che devono esser fermati con l'aggravio dell'enorme danno economico e degli inevitabili risvolti occupazionali e sociali.

Da qui si evince l'importanza del pieno rispetto della normativa che con il suo rigore formale tende a garantire nel tempo la completa tracciabilità di ogni sostanza radioattiva a qualsiasi scopo detenuta, per prevenirne ogni possibile uso improprio dovuto a negligenza o peggio alla volontà di possibili organizzazioni criminali che possano attuare progetti terroristici o comunque destabilizzanti dell'ordine pubblico, anche con la semplice minaccia di un attacco radiologico, tipo *bomba sporca*.

La Sezione Inquinamento da Sostanze Radioattive si trova anche ad affrontare situazioni in cui oltre alle normali attività di controllo e monitoraggio delle aziende regolarmente autorizzate, è chiamata in causa per cercare i responsabili di furti, abbandoni, interramenti o smaltimenti fuori da ogni controllo. Si tratta naturalmente di scenari più complessi da analizzare, dove le implicazioni scavalcano talvolta i confini nazionali, oltre al già citato fenomeno delle "sorgenti orfane" od altri in cui grandissimo risalto viene dato alle sole *voci* di possibili interramenti in discariche abusive, cave e/o miniere in disuso, di sostanze (spesso impropriamente definite *scorie*) radioattive.

4. MEZZI SPECIALI "UNIMOG" e STRUMENTAZIONE

A supporto di tutte le attività svolte, la Sezione dispone di tre automezzi speciali: due Unimog 3000 e un Unimog 5000 Mercedes, recentemente acquistati dal Ministero dell'Ambiente, progettati e allestiti con sofisticata strumentazione tecnica e pressurizzazione interna, in grado di operare in ambiente contaminato sia in ambito urbano che extraurbano. Il terzo veicolo, Unimog 5000, ha anche la funzione di laboratorio mobile, anche esso adatto ad operare in zona contaminata, con possibilità di eseguire, in aggiunta, analisi speditive per l'individuazione della tipologia dei radioisotopi su campioni ambientali, al fine di valutare la loro provenienza, l'intensità e l'estensione della eventuale grado di contaminazione.

Il personale della Sezione dispone, inoltre, di più dispositivi individuali di protezione, dai kit NBCR costituiti da tute di categoria 3 - tipo 3, abbinate ad un sistema di maschera, filtri NBC, guanti e calzature che consentono un impiego in situazioni di potenziale esposizione, ai dispositivi di categoria 3 - tipo 1 costituiti da tute a tenuta stagna di gas, associate a bombole di ossigeno e maschere munite di erogatori. Tali dispositivi di protezione consentono di eseguire sia le misurazioni della radioattività sia il campionamento di terreno, acqua ed altre matrici, per le successive fasi di analisi volte alla individuazione della sostanza radioattiva dispersa nell'ambiente, primo passo per lo sviluppo di una mirata azione investigativa anche in ambiente fortemente contaminato.

La Sezione dispone, altresì, della strumentazione campale per la rilevazione della presenza di radioattività, anche sotto forma di contaminazioni connesse alla dispersione di sostanze radioattive, costituita da rilevatori GEIGER con asta telescopica e scintillatori per le emissioni gamma, rilevatori di neutroni e rilevatori di contaminazione per sostanze radioattive di tipo alfa e beta. La strumentazione campale è stata provata anche a bordo di

aeromobili ed è allo studio un sistema di rilevazione aerea da impiegare su vaste aree di difficile accesso.

The Evolution of the Role of the Philippine Nuclear Research Institute in the National Nuclear and Radiation Safety Regime

Alumanda M. Dela Rosa

Philippine Nuclear Research Institute
Commonwealth Avenue, Diliman
Quezon City, Philippines

Abstract. The Philippine Nuclear Research Institute (PNRI), formerly the Philippine Atomic Energy Commission (PAEC) was created by law in 1958 with a dual mandate namely, to promote the peaceful applications of nuclear energy, and to regulate the safe utilization of nuclear energy. Through its almost 50 years of existence, the PNRI has assumed different roles and functions. As the premier national nuclear research institution the PNRI initiates R & D work in various applications, establishes nuclear and radiation facilities, and undertakes human resource development not only for its staff but also for the prospective users of nuclear energy. At the same time, the PNRI exercises regulatory control over radioactive materials in the country including the regulatory control over the construction of the first Philippine nuclear power plant in the late 1970's and early 1980's. Presently, the PNRI still exercises the dual mandate of promoting and regulating the peaceful and safe use of radioactive materials. In these evolving roles of the Institute, both management and the staff are committed to excellence in nuclear science and to nuclear safety. Initiatives are underway to create a separate nuclear regulatory body from the developmental agency to enable the country to conform with international safety standards and to prepare for the future re-introduction of nuclear power in the Philippine energy mix. A strong regulatory agency and an equally strong technical and scientific support organization are necessary for a successful and safe nuclear energy program.

1. Introduction

The former Philippine Atomic Energy Commission, presently the Philippine Nuclear Research Institute was created by law in 1958 to promote the peaceful applications of nuclear energy. In the same breadth, it is also mandated to regulate the safe utilization of nuclear energy in order to ensure public safety and environmental protection. In the first decade of its formative years, the PAEC undertook human resource development of its staff as well as the prospective users of radioactive materials in the country by conducting local nuclear training courses and sending scientists for graduate studies with the assistance of the International Atomic Energy Agency (IAEA). The PAEC established the first nuclear research reactor, PRR-1, and other research facilities, and initiated R & D work in various fields of application of nuclear energy. The PAEC offered the PRR-1 as the host reactor for the training of nuclear physicists and engineers in the Asian region under the India-Philippines-Agency (IPA) Project. It undertook the first site selection studies for a nuclear power plant with the assistance of the IAEA. The PAEC became the National Competent Authority on nuclear matters and the premier national nuclear research institution.

In the mid-70's the PAEC assumed a different role vis-à-vis the nuclear power program. It exercised regulatory control over the construction of the first Philippine Nuclear Power

Plant. To undertake this awesome task, the PAEC drew the needed expertise from its own scientists on the nuclear area, and the academe and private consultancy companies on the non-nuclear areas in order to evaluate the safety documents submitted by the operator. It offered the facilities of its Nuclear Training Center for the training of the staff of the operator on the basic concepts of nuclear energy prior to their deployment for further training abroad. All these activities came to naught when the country witnessed the mothballing of the Bataan nuclear power plant in 1986. The PAEC was reorganized into the present PNRI which retains the dual mandate of promoting and regulating the peaceful application of nuclear energy.

2. Present Scenario

With the mothballing of the nuclear power program, the PNRI concentrated its regulatory function on the regulation of radioactive materials and honed its expertise in this area including radiation protection, emergency preparedness and response, and security aspects. The promotional departments of the PNRI have continued with R & D on various areas of nuclear applications, and have enhanced their nuclear services including radiation protection services and the conduct of nuclear training courses. In some instances, these departments assist the regulatory arm of the PNRI in generating data related to radiation safety.

Since the law exempts the facilities of the PNRI from regulatory control, the PNRI instituted an internal regulatory program for its radiation facilities and radioactive materials in its possession. The promotional departments referred to as users are under the supervision of a Radiation Safety and Security Board which submits to the regulatory department of PNRI applications for a permit to use radioactive materials in PNRI. The regulatory department evaluates such application and conducts a site survey if necessary, and issues the permit when all requirements are met by the user. This program hopes to enhance radiation safety in the use of radioactive materials within the PNRI, and strengthens safety culture among PNRI scientists.

Preservation of nuclear knowledge particularly on nuclear engineering and fields related to nuclear power is a major concern of the Institute. In view of the lack of government policy on nuclear power for the past 20 years and with the retirement of trained staff, the PNRI has not been able to sustain its knowledge base on nuclear power, and the academe also stopped its graduate program in nuclear engineering. The situation is exacerbated by the fact that young engineers are discouraged to pursue a program in nuclear engineering. This situation, if not addressed, will have a significant impact on future nuclear power program in the country.

3. Evolving nuclear infrastructure in the Philippines

A draft Nuclear Regulatory Act has been prepared for submission to the Philippine Legislature. It provides for the creation of a separate nuclear regulatory body to have regulatory control over radioactive materials and electronic devices emitting radiation. The present PNRI will remain as the national nuclear research institution to promote the

peaceful applications of nuclear energy. It has the expertise and facilities to serve as a technical and scientific support organization (TSO) in enhancing nuclear and radiation safety. A clear delineation of the roles and functions of the two independent nuclear agencies will benefit in strengthening the national nuclear program. The new regulatory body will have the independence to implement its nuclear regulations and can tap the expertise of the TSO in matters relating to nuclear and radiation safety. The PNRI will no longer be constrained in fully promoting the benefits of nuclear energy, and can develop itself into a TSO.

Recruitment of additional manpower and human resource development would be a priority program for the new regulatory body and for PNRI. Inasmuch as the government is seriously assessing the possibility of including the nuclear option in its energy plan by 2018, the most important component of the nuclear power program that should be considered by the government is the availability of human resources and the training of the staff of the PNRI, the new regulatory body, the prospective operator, and the academe. The government is now addressing this concern.

The creation of a separate and independent nuclear regulatory body is another requirement that the government must address before it embarks on a new nuclear power program.

The role of CNEA as a TSO in the Enhancement of Nuclear Safety

C. J. Gho

Comisión Nacional de Energía Atómica – Argentina
gho@cab.cnea.gov.ar

Argentina's National Atomic Energy Commission (CNEA) was created in 1950 to promote the development of the pacific technological applications of nuclear energy within the country.

Since its very beginning CNEA considered that nuclear development is possible only if it is supported by broad scientific knowledge and accompanied by an adequate progress of the needed technological capacities. Thus, an important investment was done to educate and prepare professionals to form a technical staff that had broad backgrounds; as a consequence, excellent educational and training Institutes were created, and a number of researchers, engineers and technologists were educated. Since the early days, CNEA has paid special attention to crucial aspects such as radiological protection and nuclear safety.

CNEA has had a role in contributing to the national growth of Argentine scientific and technical sector. This role has been necessary not only to provide the basis for the development in national nuclear industry but also to set up its own professional staff, which lately gave technical and scientific support to the emerging sector. This was done by means of agreements with the main Argentine Universities as a new way to educate and train professional and efficient staff.

Instituto Balseiro (IB) was the first Centre established by CNEA and the University of Cuyo in 1955 in Bariloche, to train physicists and nuclear engineers. A revolutionary method of teaching has been adopted: the students study and reside at the Institute and work together with their professors, who are active and skilled researchers. IB is also known for:

- Selecting promising applicants (intelligent, responsible)
- Having a strong background in the basic sciences of engineering
- Instilling work ethic and environmental commitment

As a result, the graduates from IB have highly convenient skills at working in TSOs like CNEA; such as:

- Being hard-working professionals;
- Having solid experimental and theoretical background in thermohydraulics, neutronics, material sciences, computing and nuclear engineering.
- Being in constant close contact with other countries' universities and academic knowledge at international level (with subsequent professional training and specialization).
- Proving to be efficient and enthusiastic professionals when facing new challenging problems.
- Having versatility to deal with problems in different areas, apart from their speciality.
- Having affinity for plant and routine work.

- Commitment with the environment and work ethic.

After IB foundation, several Institutes were set up that specialise in metallurgy, radiochemistry, nuclear materials and radiological protection.

This policy of CNEA led to a sudden transformation of the national science and technology, and by the middle of the sixties the country already had a much higher scientific basis than the one in 1950 which was beyond the scope of nuclear field.

In those days, the construction of the first experimental reactors and other relevant nuclear facilities were possible thanks to that sustained development. It is convenient to point out that in the sixties the Argentine local industry was not producing standard quality goods and services suitable for nuclear projects. The materials and equipments for those projects were produced by CNEA laboratories. This was the evidence that the country needed another quantum leap if it aimed to fully devote to nuclear business.

During the late sixties and the early seventies a decision was made to build the first Latin American Nuclear power Plants.

Atucha I y Embalse NPPs Projects were only the first steps to promote an important technological development of the local industry and contractors. The national industry, with CNEA strong and permanent support and with these two Projects, had a necessary improvement of quality. A wide-ranging Technical Support programme allowed local industries—which previously were not capable of fulfilling the nuclear industry quality requirements—to be thereafter in good condition to successfully take place in international technological complex projects regarding nuclear subjects and other things. This fact must be regarded as one major success of CNEA in its role of TSO.

During the eighties the structure of CNEA gathered the functions of NPP Operation, Regulatory Body and Scientific and Technological Support to both areas, including the mastering of all the aspects of fuel cycle.

This concentration of responsibilities was explainable only if the adverse starting conditions in 1950 and the smallness of the national nuclear program were considered. The human resources were still scarce, and thus it was very difficult not to share them for many functions. This is probably the case still now.

In 1994 the (old) CNEA was split into three new Organizations, having clear individual purposes. A Company (utility) was created to operate the existing NPPs and to build new ones, particularly Atucha II, Nucleoeléctrica Argentina Sociedad Anónima (our “NASA”). A Nuclear Regulatory Authority (ARN) was set, and it was given the necessary independence to perform safety controlling. Last but not least, the (new) CNEA explicitly assumed the status of TSO not only for ARN and NASA, but also for the whole nuclear area, backing nuclear installations construction and/or operation, assessing on safety and radiological aspects of regulatory controls, supporting nuclear industry not only concerning

nuclear power, but also the many others peaceful applications of atom, like agriculture, food, health.

In spite of that this splitting might be seen as logic, the immediate result was that CNEA (and the whole nuclear field) were negatively affected. When NASA was created most of the staff in conditions to give technical and scientific support to the NPPs operation were moved from CNEA to the utility. In a similar manner, the personnel working on nuclear safety and radiological protection needed to set up the Regulatory Authority were also transferred. Thus, the capability of CNEA (residual) to act as a TSO was strongly affected.

The 90's were characterized by a sharp fall of nuclear image all over the world, and these bad effects were strongly felt in Argentina as well. The Country's Political Scenario encouraged financial speculation over services and goods production, and deeply influenced on the labour vocation of the young Argentines, who relegated their choice of careers on Sciences or Engineering and were massively attracted by studies and activities related to managerial or financial aspects. In addition, the National Government Policy was to give lesser consideration to CNEA's (and many other technical organizations of the State) needs regarding the management of their staffs, in the frame of a strong privatization.

Within this frame, the task of rebuilding and keeping the scientific and technological knowledge was very cumbersome, and CNEA's efforts to overcome this situation were tough but successful. This success is related with two main factors:

From one side, as it was told previously, there exist the Academic Institutes which CNEA has been running in association with the country's main Universities. They have a notorious prestige in the field of High Education in Argentina. Even during those years, a significant number of Physicists, Nuclear Engineers, Materials Engineers and Radio Chemists were formed in these CNEA Institutes. (This is an extraordinary effect of giving priority to basic knowledge: most of graduates continued their careers in fields different from nuclear, but a small group could be retained for CNEA's purposes).

From the other side, related to professional expertise, Argentina had a relevant success in exporting nuclear facilities worldwide, as for instance the Research Reactors and Labs that were built in Peru, Algeria, Egypt and Australia, where the participation of CNEA as TSO was crucial.

In effect, in spite of the nuclear stagnation Argentina participated in several nuclear projects related mainly to exports of experimental reactors. As the main constructor of these projects was INVAP (a Company ruled by the State of Rio Negro) the role of CNEA was to give technical support and technology transfer to this Company and to the Projects owners.

Within this frame many aspects like neutronic core design, thermal-hydraulics of cooling circuits, safety studies including PSA, fuel design and construction,

instrumentation and control, set-up of operating criteria, staff training and commissioning procedures were almost fully carried on by the groups of CNEA.

As well as this, CNEA has continued to give support to NASA for the NPPs operation. CNEA staff mainly carried out a huge monitoring programme—including Atucha's RPV surveillance—and a successful project on the use of slightly enriched (instead of natural) uranium—.

These two sources of work, the participation in projects to build nuclear installations abroad and the local support to NASA, as well as the many own research works, allowed CNEA to be active during these dark days for nuclear energy, and therefore it is in a reasonably good condition to face the new problems arising on the foreseen restart of nuclear industry.

Conclusion

These days the world seems to bring a renewed interest to nuclear energy, and this “nuclear rebirth” has also arrived in Argentina, where relevant nuclear projects are restarted, such as Atucha II completion, the construction of the first prototype for CAREM concept reactor, the studies for Embalse's life extension and the start up of the uranium enrichment pilot plant.

In spite of a present lack of personnel, CNEA is in good condition to produce new job positions to complete its staff in order to give a thorough support to these important projects. Besides it provides current backing of NPPs and other nuclear facilities.

THE ROLE OF THE CNEA LIKE ORGANIZATION OF SCIENTIFIC AND TECHNOLOGICAL SUPPORT TO ACCENTUATE THE NUCLEAR SECURITY

The activity developed by the CNEA in this subject from its creation, is based on an attitude responsible in the care for the people, the society and the environment, conduct that has remained after its restructuring in 1994. PEN N° 1540/74 decree transferred the nuclear power generation activity to NUCLEOELECTRICA ARGENTINA S.A. and the regulatory activities to the ENTE NACIONAL REGULADOR NUCLEAR, today NUCLEAR REGULATORY AUTHORITY (ARN).

The CNEA has the following attributions by Law N° 24,804/97 "National Law of the Nuclear Activity", regulator of the Nuclear Activity in the Argentine Republic that it establishes, among other aspects, that the CNEA will have:

- a) Advising the Executive Power on nuclear policy issues.
- b) Promoting training of highly specialized human resources, scientific and technological developments in the nuclear field, and including the promotion and development programs for technological innovations.
- c) Fostering technology transfer programs for the technology that was obtained and developed by the Institution, and for which the Institution has a patent, in compliance with the non-proliferation commitments signed by the Argentine Republic.'
- d) Exercising the responsibility of radioactive waste management activities as established by the specific law.
- e) Defining the procedures for decommissioning nuclear energy generation facilities and all other relevant radioactive installations.
- f) Providing the services requested by nuclear power plants and other nuclear installations.
- g) Exercising the rights of the National Government on special fissionable materials included in irradiated fuel elements.
- h) Exercising the rights of property of the National Government on special fusion materials, which are imported or developed in the country.
- i) Developing, building and operating experimental nuclear reactors.
- j) Developing uses for radioisotopes and radiation in biological, medical and industrial applications.
- k) Performing exploration of minerals for nuclear use, without excluding the private sector from said activity.

l) Developing materials and manufacturing processes for fuel elements used in advanced cycles.

ll) Developing basic and applied research programs in basic science of nuclear technology.

m) Establishing cooperation programs, through the Ministry of Foreign Affairs, International Trade and Worship, with third countries for the above mentioned basic and applied research programs, and for fusion technology research and development programs.

n) Fostering and developing other studies and scientific applications for nuclear transmutations and reactions.

ñ) Continuously updating the technical information on nuclear power plants and their various stages, and ensuring its optimum use.

o) Establishing direct relations with other foreign institutions that share similar goals.

On the other hand, the Law N° 25,018 "Regime of management of Radioactive waste" establishes the basic legal regime applicable to the management of the radioactive waste. It defines radioactive waste and it arranges that the National State will be responsible by the management for such, once the transference of the generator to the State has an operation.

Also, the regulatory frame stated by the NUCLEAR REGULATORY AUTHORITY norms, in the area of the radiological and nuclear safety, guarantees of nonproliferation, physical protection and transport of radioactive material, in its character of national authority and that are of obligatory fulfillment for all the operators.

Within this context and considering these objectives the CNEA in the matter of Nuclear Safety makes the management of spent fuel components and of originating radioactive waste of the state and deprived nuclear activity, the dismantling of radioactive nuclear power plants at the end of its life utility, the works of decontamination and the environmental restitution of the facilities and estates jeopardize with radioactive processes, including the sites affected to the extraction and processing of uranium, to leave the installation in a safe condition in the long term.

For fostering it:

- Applied effective, safe practices and ecologically conceived so that in all the processes it has been adopted measures against potential radiological risks, in order to protect the people, the society and the atmosphere of the injurious effects of the ionizing radiations.
- Develop a culture of continuous improvement of all the processes and services related to the activity, impelling the optimization of resources.
- Applied measures of physical protection, radiological safety and environmental protection during the development of all his activities.
- Exerting inherent investigation and development to the management of radioactive waste and studies on safety and preservation of the atmosphere.

El Rol de la CNEA como Organización de Apoyo Científico y Tecnológico para acentuar la Seguridad Nuclear

La actividad desarrollada por la CNEA en este tema desde su creación, se basa en una actitud responsable en el cuidado de las personas, la sociedad y el ambiente, conducta que se ha mantenido después de su reestructuración en 1994, momento a partir del cual por Decreto del PEN N° 1540/74 se transfirió la actividad núcleo eléctrica a NUCLEOELECTRICA ARGENTINA S.A. y las tareas de regulación al ENTE NACIONAL REGULADOR NUCLEAR hoy AUTORIDAD REGULATORIA NUCLEAR.

La CNEA tiene las atribuciones que le otorga la Ley N° 24.804/97 “Ley Nacional de la Actividad Nuclear”, reguladora de la Actividad Nuclear en la República Argentina que establece, entre otros aspectos, que la CNEA deberá:

- a) Asesorar al Poder Ejecutivo en la definición de la política nuclear;
- b) Promover la formación de recursos humanos de alta especialización y el desarrollo de ciencia y tecnología en materia nuclear, comprendida la realización de programas de desarrollo y promoción de emprendimientos de innovación tecnológica;
- c) Propender a la transferencia de tecnologías adquiridas, desarrolladas y patentadas por el organismo, observando los compromisos de no proliferación asumidos por la República Argentina;
- d) Ejercer la responsabilidad de la gestión de los residuos radiactivos cumpliendo las funciones que le asigne la legislación específica;
- e) Determinar la forma de retiro de servicio de centrales de generación nucleoelectrica y de toda otra instalación radiactiva relevante;
- f) Prestar los servicios que le sean requeridos por las centrales de generación nucleoelectrica u otra instalación nuclear;
- g) Ejercer la propiedad estatal de los materiales radiactivos fusionables especiales contenidos en los elementos combustibles irradiados;
- h) Ejercer la propiedad estatal de los materiales fusionables especiales que pudieren ser introducidos o desarrollados en el país;
- i) Desarrollar, construir y operar reactores nucleares experimentales;
- j) Desarrollar aplicaciones de radioisótopos y radiaciones en biología, medicina e industria;

- k) Efectuar la prospección de minerales de uso nuclear, sin que ello implique excluir al sector privado en tal actividad;
- l) Efectuar el desarrollo de materiales y procesos de fabricación de elementos combustibles para su aplicación en ciclos avanzados;
- 11) Implementar programas de investigación básica y aplicada en las ciencias base de la tecnología nuclear.
- m) Establecer programas de cooperación con terceros países para los programas enunciados en el inciso precedente y para la investigación y el desarrollo de la tecnología de fusión a través del Ministerio de Relaciones Exteriores, Comercio Internacional y Culto;
- n) Promover y realizar todo otro estudio y aplicación científica de las transmutaciones y reacciones nucleares;
- ñ) Actualizar en forma permanente la información tecnológica de las centrales nucleares en todas sus etapas y disponer del aprovechamiento óptimo de la misma;
- o) Establecer relaciones directas con otras instituciones extranjeras con objetivos afines;
- p) Celebrar convenios con los operadores de reactores nucleares de potencia, a los fines de realizar trabajos de investigación.

Por otro lado, la Ley N° 25.018 “Régimen de gestión de Residuos Radiactivos” establece el régimen jurídico básico aplicable a la gestión de los residuos radiactivos. Define residuo radiactivo y dispone que el Estado Nacional será responsable por la gestión de los mismos, una vez que se opere la transferencia del generador al Estado.

Asimismo, el marco regulatorio está dado por las Normas dictadas por la AUTORIDAD REGULATORIA NUCLEAR, en el área de la seguridad radiológica y seguridad nuclear, garantías de no proliferación, protección física y transporte de material radiactivo, en su carácter de autoridad nacional y que son de cumplimiento obligatorio para todos los operadores.

Dentro de este contexto y teniendo en cuenta estos objetivos la CNEA en Materia de Seguridad Nuclear realiza la **gestión de elementos combustibles gastados y de residuos radiactivos** provenientes de la actividad nuclear estatal y privada, el desmantelamiento de instalaciones nucleares radiactivas al final de su vida útil, los trabajos de descontaminación y la **restitución ambiental** de las instalaciones y predios comprometidos con procesos radiactivos, incluyendo los sitios afectados a la extracción y procesamiento del uranio, para dejar la instalación en una condición segura a largo plazo.

Para ello:

- Aplica prácticas eficaces, seguras y ecológicamente bien concebidas para que en todos los procesos haya medidas adecuadas contra los riesgos radiológicos potenciales, a fin de proteger a las personas, la sociedad y el ambiente de los efectos nocivos de las radiaciones ionizantes.
- Desarrolla una cultura de mejoras continuas de todos los procesos y servicios relacionados con la actividad, impulsando la optimización de los recursos.
- Aplica medidas de protección y seguridad radiológica y de protección física y ambiental al desarrollo de todas sus actividades.
- Propicia la investigación y desarrollo inherentes a la gestión de residuos radiactivos y estudios sobre seguridad y preservación del ambiente.

The Establishment and Practices of TSOs for Chinese Nuclear Regulatory Body

HAO Xiaofeng

State Environmental Protection Administration
(National Nuclear Safety Administration)
Beijing 100035, P.R.China

Abstract: Based on the requirements of Agency's safety standard GS-R-1 《Legal and governmental infrastructure for nuclear, radiation, radioactive waste and transport safety》 and more than twenty years' practices in China, this paper presents the development of Technical Support Organizations (TSOs) of the Chinese nuclear regulatory body from the points of view of the practices, features, functions, challenges faced and counter measures etc.. The TSOs of the Chinese nuclear regulatory body have been founded and enhanced according to the continuously increased responsibilities and functions on nuclear safety supervision, and are aiming at providing full scale technical supports to the Chinese nuclear regulatory body in the areas of law making, nuclear safety review and evaluation, nuclear safety inspection, emergency preparedness and response, independent monitoring and check-up, scientific research, personnel training, quality assurance, information system establishing, international cooperation etc..

Key words: nuclear safety, supervision, technical support, functions

1. Introduction

More than 50 years' history of peaceful use of atomic energy worldwide shows that atomic energy acts as a two-edged sword, while it is benefiting the human being, it may also bring the catastrophe to the human being if misgoverned. The Chernobyl nuclear accident not only caused enormous economic lost, but also left a deep shadow in the mind of the public. In this regard, the nuclear safety supervision differs from the governmental supervision on the traditional industries. Governments shall recognize the importance of the issue and take effective supervision modes and measures to protect the public and environment from the damage.

The use of atomic energy concerns a lot of high technology. So an effective nuclear safety supervision needs a powerful technical support. Moreover, many member states have developed their own nuclear safety supervision modes. In many member states, the staff number of nuclear safety regulatory bodies can only meet the basic requirements of some administrative management due to the limit of the scope of governmental infrastructures. In this context, more technical work has to be done by TSOs.

Many helpful practices and exploration have been performed worldwide and many useful experiences have been gained. A comprehensive international cooperation will be helpful to enhance the capacity of nuclear safety regulatory bodies and its TSOs, which conform to member states' interests and will be helpful to achieve a consistently high safety level.

2. Responsibilities and functions of Chinese nuclear safety regulatory body

According to Agency's safety standard GS-R-1 《Legal and governmental infrastructure for

nuclear, radiation, radioactive waste and transport safety》, the responsibilities and functions of regulatory body include defining policies, safety principles and associated criteria; establishing, promoting or adopting regulations and guides; reviewing and assessing submissions on safety from the operators; providing for issuing, amending, suspending or revoking authorizations; carrying out regulatory inspections; ensuring that corrective actions are taken if unsafe or potentially unsafe conditions are detected; and taking the necessary enforcement action in the event of violations of safety requirements.

The regulatory body may also have additional functions. Such functions may include independent radiological monitoring in and around nuclear facilities; independent testing and quality control measurements; initiating, co-ordinating and monitoring safety related research and development work in support of its regulatory functions; providing personnel monitoring services and conducting medical examinations; monitoring of nuclear non-proliferation; and regulatory control of industrial safety.

Chinese nuclear regulatory body (National Nuclear Safety Administration-NNSA) has adopted almost all the responsibilities and functions mentioned above by GS-R-1. After more than 20 years' practices, NNSA has formed its own infrastructure and supervision mode. The main responsibilities and functions of NNSA can be summarized as followings:

- nuclear safety related law, policy and associated code, regulation and guide making;
- nuclear safety related technical standard review;
- nuclear safety review and evaluation;
- nuclear safety inspection;
- licensing process and enforcement ;
- nuclear safety related accident investigation and treatment;
- operational event evaluation and experience feedback;
- emergency preparedness and response;
- independent monitoring and check-up;
- scientific research;
- personnel training;
- quality assurance;
- public propaganda;
- international cooperation etc.

These responsibilities and functions of NNSA may be extended or adjusted according to the real needs arising from our nuclear development in the near future.

3. Establishment and practices of TSOs for the Chinese nuclear regulatory body

Just at the beginning of the foundation of NNSA in 1984, we faced the challenge to perform the safety review for Qinshan and Daya Bay nuclear power plants. Very soon we realized that a temporarily organized review team could not satisfy the continuously increased needs arising from our nuclear development plan. We realized also the importance to establish our own technical support organization to provide full scale technical supports. So in 1989, NNSA established his own technical support organization: Nuclear Safety Center.

In 2006, Nuclear Safety Center was renamed to Nuclear and Radiation Safety Center. At present, this center has been developed to be a powerful technical support organization to NNSA with 14 divisions including legislation & information, reactor system & analysis, mechanical

equipment & QA, electricity supply and I&C, siting & structure, radwaste management & fuel cycle, radiation protection & emergency response, nuclear installations operational safety, and radioactive sources safety etc.. The total staff number is going to be increased to 177 in several years.

The experts of the center have undertaken a lot of tasks of safety review, inspection, emergency response and scientific research etc. from NNSA. Some important work completed in the past include the safety review of Qinshan Phase II (Unit 1, 2, 3, & 4), Ling Ao (Unit 1, 2, 3, & 4) and Tianwan (Unit 1 & 2); the establishment of nuclear and radiation accident emergency response and evaluation system, nuclear installations operational experience feedback system, nuclear safety management data banks and nuclear safety information system etc..

Radiation Environment Monitoring Technical Center is one of the technical support organizations of State Environmental Protection Administration (SEPA). Because NNSA was combined into SEPA in 1998, this center provides also the technical support to NNSA for independent radiological monitoring in and around nuclear facilities thereafter.

Beside the Nuclear and Radiation Safety Center and the Radiation Environment Monitoring Technical Center, NNSA has sought for assistance from some other organizations such as universities, research and design institutes. However, when these organizations provide technical support to NNSA, they must ensure the independence from organizations or bodies charged with the promotion of nuclear technologies or responsible for facilities or activities.

- Suzhou Nuclear Safety Center (Suzhou Nuclear Power Research Institute Co. Ltd.) provides technical support to NNSA in the area of QA.
- The major work of Nuclear Equipment Safety and Reliability Research Center (China Academy of Machinery Science and Technology) is to verify the availability of the nuclear component in which the non-conformity has occurred and provide enough technical proof to NNSA for their final administrative decision.
- Beijing Nuclear Safety Review Center (Beijing Institute of Nuclear Engineering) provides technical support to NNSA on CANDU reactor safety review and operational management.
- Tsinghua University provides technical support to NNSA in the area of PSA.
- Shanghai Jiaotong University provides technical support to NNSA in the area of severe accident management.

4. Features of TSOs for the Chinese nuclear regulatory body

The orientation of TSOs in China is to provide comprehensive technical support to NNSA to fulfil effectively and efficiently its responsibilities and functions. This orientation decided some particular features as followings:

- Independence from industries;
- Non-profit and public welfare institutions;
- Full funding from Government;
- High technology and professional;
- Special treatment policy needed to stabilize the team;
- Independent audit calculation and testing capacity needed etc..

5. Functions of TSOs for the Chinese nuclear regulatory body

Except the administrative activities, the TSOs for the Chinese nuclear regulatory body assist NNSA comprehensively to discharge its assigned responsibilities and functions. Their functions concern the following areas:

- Nuclear installations safety review, evaluation and inspection;
- Environmental impact evaluation;
- Operational events evaluation and experience feedback;
- Emergency preparedness and response (including accident consequences evaluation and prediction);
- Nuclear safety related law, policy and associated code, regulation and guide making;
- Radwaste management;
- Radiation protection;
- Independent radiological monitoring in and around nuclear facilities
- Nuclear material management;
- Transport safety;
- Nuclear pressurized equipment and components,
- Radioactive sources management;
- International cooperation;
- Scientific research;
- Training;
- QA;
- Developing independent audit calculation and testing capacity;
- Nuclear safety engineer registration;
- Nuclear safety information etc..

6. Challenges faced by the TSOs for the Chinese nuclear regulatory body

China is a developing country. Recently, we have launched an ambitious nuclear program. It is predicted that by the end of 2020, we will achieve the aim of 40,000MWe nuclear power capacity, which takes 4% of total national power capacity. That means we have to start the construction of at least two 1000MWe-units every year. The TSOs for the Chinese nuclear regulatory body are facing the big challenges:

- Lack of competent staff;
- Lack of enough financial support;
- Lack of the experience to review the new generation nuclear power plant (AP1000, EPR);
- Lack of independent audit calculation and testing capacity
- Multiple designs with different techniques etc..

7. Counter measures available

NNSA and its TSOs have realized the challenges and prepared actively the counter measures.

- The application for increasing the staff has been approved by the Government. We have set up a plan to recruit the new staff as soon as possible.
- Recent years, we have gotten an increased financial support year after year from the Government. The problem of lack of enough financial support for the TSOs has been mitigated a lot.

- We will reevaluate the real need on staff and finance based on the developing requirement, and strive for more support from the Government in order to create the necessary working conditions to improve the nuclear safety supervision capacity.
- Facing the intense competition from the industries, we are studying the possibility to request special policy from the Government to avoid staff leaving, stabilize the team and absorb more skillful staff.
- We are seeking for the cooperation with universities and industries for our staff training and education, and have gotten active responses. Moreover, we are contacting IAEA, Westinghouse and USNRC for staff training.
- We are sure that a comprehensive international cooperation will be helpful for us to deal with the challenges, and improve the effectiveness, efficiency and level of our nuclear supervision.

end

Role of Technical Support Activities for Enhancing Design and Operational Safety of Nuclear Plants

U.L. Sharma,

Head, Quality Assurance Section
Research Reactor Services Division
Bhabha Atomic Research Centre
Mumbai 400 085

P.V. Varde

Head, Performance Evaluation & Safety Section,
Research Reactor Services Division
Bhabha Atomic Research Centre
Mumbai 400 085

Abstract: This paper presents the technical support activities for the three research reactors operating at BARC. The technical support programme has evolved over the years, since late sixties when Apsara came into operation. While on one hand the volume of activities have increased consequent to commissioning of two more reactors Cirus and Dhruva in 1960 and 1985 respectively, attempts were made to enhance effectiveness of the technical support activities for these research reactors. The activities range from monitoring of various safety and operational aspects to some of the state of the art approaches that has been developed for enhancing safety and reliability of the plant. The aim of technical support programme is to enhance plant availability factor without comprising the safety of the plant. This paper discusses the existing programme of technical support activities in reactor group of BARC and further work required to strengthen technical support activities to realize enhanced safety and reliability for research reactors at BARC. Accordingly, this paper fits in the conference topic 1: Roles, functions and values of TSOs.

1. INTRODUCTION

There are three research reactors viz Apsara (1.0 MWt), Cirus (40 MWt) and Dhruva (100 MWt) operated by reactor group at BARC, Mumbai, India. Research Reactor Services Division of Reactor Group is responsible to provide the scientific and technical support in the design, operation and utilization of the research reactors. The main objective of various technical support activities is to ensure the required level of safety and adequate defense-in-depth provisions towards realizing enhanced safety and reliability of the research reactors.

2. ORGANIZATIONAL SETUP

The Reactor Group at BARC has the responsibility for operating and maintaining the three research reactors at BARC. Research Reactor Services Division is responsible for the technical support activities of the research reactors. The major support and developmental activities that are performed as part of technical support are: a) design and planning for various engineering modifications, b) reactor physics support for core management and re-assessment of physics parameters, c) quality assurance activities, d) Chemical control support, e) In-service inspection and conditioning monitoring, f) performance evaluation and safety assessment and g) Man power training and development.

3. TECHNICAL SUPPORT – AN OVERVIEW

The major activities covered under technical and scientific support programme are

3.1. Safety Analysis

The *Deterministic safety analysis* forms the basic approach for safety analysis. Accordingly, the Design Basis Events (DBE) forms the basis of research reactors design. The DBE for research reactor include normal operation, operational transients and Postulated Initiating Events (PIEs). The identification and categorization of PIEs is based on combination of iteration between design &

analysis, engineering judgment and experience from similar plants in operation. To ensure that the list of PIEs is as complete as possible, the classification of PIEs cater to international criteria set for this purpose, list given in IAEA Safety guide for research reactor SG-31 and. our national regulatory guides for PHWRs established by the regulatory authority.

The design basis events are categorized on the basis of their expected frequency of occurrence and are assigned to one of the following frequency groups; Category – 1 events: Normal operation and operational transients, Category – 2: Events of moderate frequency, Category – 3: Events of low frequency, Category – 4: Multiple failures and rare events. Events not falling in any of the above categories are categorized as Beyond Design Basis Event (BDBE). The deterministic approach forms the basic approach for handling safety and operational issues, the Probabilistic Safety Assessment (PSA) inputs are increasingly being utilized to complement / supplement deterministic findings.

3.2. Design & Engineering Services

Research Reactor Services Division is the nodal technical support organization to assist operators and maintainers in design and engineering changes. Ageing management of systems and components, repair and rehabilitation of components in inaccessible locations through design and development of remotely operated tools and required modifications of the ageing structures and components to bring them to the current seismic standards are some of the challenges faced by technical support organizations. Some of the very important design and engineering modifications carried out in this category are as follows:

1. Leak rectification from Tongue and Groove joints in helium vent lines located in the inaccessible area above Cirus reactor vessel. A detailed study was performed to work out the strategy and sequence of installation and sequential tightening of the specially designed and fabricated slip on type split flanges assemblies to encase the existing tongue and groove flange joints at nine locations using specially designed tools for remote installation and tightening of the same. Engineering challenge in carrying out this job was ensuring safety of the nine numbers of rolled joints of the helium vent lines in the upper tube sheet which has seen material degradation during 35 years of service in presence of high neutron flux.
2. Rectification of leak in one of the inlet cooling water lines of upper thermal shield of Cirus reactor. This was done by design, development and installation of a hollow aluminum plug which was installed at the leaky location through specially designed tools for remote installation.
3. Seismic retrofitting and up gradation of water storage tank for decay heat removal and emergency core cooling system of Cirus reactor to comply with the current safety standards.
4. Replacement of some safety important valves and pipe lines was also carried out
5. For improving fire safety in the plant, fire barriers were retrofitted between the emergency Diesel Generator Sets and Motor alternator sets. All control and power cables were also provided with fire retardant coatings.

Cirus reactor has been re-commissioned and is operating at rated power after incorporation of these repairs and upgrades.

3.3. Quality Assurance

A comprehensive quality assurance programme covering all the operational and maintenance activities has been implemented to strengthen the safety culture and enhancement of safety through self-assessment of operational performance. The quality assurance programme includes monthly technical audits of operational and maintenance activities, performance review of systems and equipments, checking compliance with technical specifications in all activities with specific emphasis on surveillance schedules, ensuring implementation of recommendation of various safety committees and compliance with radiological and industrial safety measures in all O&M activities. Bi-annual internal regulatory inspections covering operations, maintenance, technical services and radiation safety aspects through auditable documentation forms an important part of quality assurance programme. Quality Assurance Section in Reactor group carries out independent verification of O&M procedures of all safety systems and equipment, and any engineering design changes including the execution of the changes.

3.4. Reactor Physics and Nuclear Engineering

Nuclear reactors have potential to generate a large amount of radioactivity and radiations. In order to prevent the inadvertent release of radioactivity from the system the core should be managed safely from reactivity and cooling considerations. Operational reactor physics essentially deals with systematized application of physics safety principles to ensure that the reactor is operated within design limits with adequate safety margins. To ensure this important aspect, we have a Reactor Physics and Nuclear Engineering Section in place with qualified physicists. They mainly cover Physics Programs in the areas to ensure safe operations such as: Core reactivity surveillance, Core loading evaluation, Low power reactor start-up, Safety evaluation of in-pile irradiation samples and experimental assemblies.

One of the important utilization of high flux research reactors is to produce radioisotopes and testing of experimental fuel and other assemblies. The evaluation for such irradiation requirements mainly consists of calculation of reactivity effects, nuclear heating, radioactivity generation and radiation shielding requirements for safe post irradiation handling, transportation and disposal. For carrying out the above evaluations on routine basis a computer code SHARDA (Sample Heating, Activity, Reactivity, and Dose Analysis) has been developed. This section is also responsible for physics design of new reactors and core up-gradation of existing research reactors, Apsara.

3.5. Reactor Chemistry

Stringent chemistry control of coolant and moderator system is essential to minimize corrosion of systems and components and the consequent neutron activation of corrosion products and their re-deposition in low velocity zones of system piping and components. Keeping corrosion products low helps in maintaining low levels of radioactivity in operational area resulting in lower dose to operating personnel. Control of Fe and silicon content in the coolant water is essential for improved fuel performance. Control of Nitrogen in cover gas of heavy water tank type reactors is necessary to prevent formation of nitric acid. Further, accumulation of $D_2 + H_2$ due to radiolytic decomposition of moderator heavy water can lead to chances of forming explosive mixture in the cover gas system if not properly taken care of. Proper chemistry control is one of the important performance indicators. In addition to routine jobs as mentioned above, the Reactor Chemistry Section has contributed significantly in solving some of the intricate operational problems; one example is development of special magnesium based resin beds to remove aluminum turbidity from the Dhruva heavy water coolant system encountered during initial power operation due to flow induced vibrations of the fuel clusters.

3.6. In-Service Inspection Programme

Strict quality assurance programme is followed during design, manufacturing and commissioning stages of the research reactors. However, service and environmental induced material degradation during operation of plant is a reality. However, based on the criteria followed in power reactors, the components used in research reactors were assessed to be falling in C2 inspection category for which no ISI is normally recommended and no inspection programme were in existence earlier. Considering the power level, radionuclide inventory and exposure potential to personnel, an ISI programme for research reactor was recently formulated and is being implemented in High flux research reactors, Dhruva and Cirus.

As the ISI programme was being taken up for the first time without Pre-Service Inspection, its implementation posed some difficulties due to lack of fabrication details, accessibility problems, difficulties in planning and scheduling of inspection jobs during shut down periods without affecting other jobs, lack of baseline data for comparison, non availability of codes/guides which can be readily applied in the case of research reactors.(barring IAEA-TECDOC-746), fixing an acceptance standard and evaluation of observed data etc. For ISI the following main systems are included;

- (i) Main Coolant, moderator and cover gas (Heavy Water and Helium Gas)
- (ii) Emergency Core Cooling
- (iii) Decay heat removal

In addition, some of the important systems and components covered are:

- Calandria Tubes Inspection in Cirus
- Pressurised Water Loop Inspection in Cirus
- Containment Building Inspection of Cirus

3.7. Human Resource Development for Research Reactors

To ensure that competent and safety conscious personnel are available on a continuous basis to man our research reactors a manpower training and development section is an integral part of our organizational structure. The recruitment is done at three levels namely professionals, supervisory staff and plant operators / maintenance technicians. The section conducts comprehensive training for all levels towards meeting the licensing requirements as operator or maintainer. To verify the continued competence each and every licensed person is re-assessed every three years. This re-assessment consists of an interview by the designated committee to check out his knowledge base, especially in the area of safety and changes in the plant systems and procedures. Periodic refresher training programme is also held to up-date and enhance the knowledge and skill.

4. RESEARCH & DEVELOPMENT IN TECHNICAL SUPPORT

Even though the current framework has served well which is reflected in the high availability factors of the research reactors, improvements are expected to further broaden the areas of technical support activities to include the state-of the art developments in the area of safety and reliability. The recent developments in the area of Probabilistic Safety Assessment as part of implementation of risk-informed approach, state-of-the-art development in the area of condition monitoring techniques, development of computer based applications, and advances in the area of digital systems, especially for safety critical

applications, have provided the nuclear community to further improve safety and performance of the reactor systems. Keeping in view the requirements of continuous improvements of safety and availability for research reactors at BARC, R&D work has been taken up. Some of the highlights of the work that is being performed as part of technical support are as follows:

4.1. Level 1 PSA for Dhruva has been completed and for Cirus the study is in advanced stages of completion. The current state of the art has allowed us to use PSA input for evaluation of impact of safety significance of the events, assessment of modifications in the safety systems, regulatory review of performance of safety critical systems. There are some studies that have been performed in support of decisions related to implementation of changes. The quantified output of this analysis provides an elegant mechanism for generating rationales for various decisions like prioritization of the safety issues.

R&D work on some of the PSA applications as part of development of risk-informed technologies that are being extensively persuaded include, a) Risk-Based In-service Inspection Programme, b) Development of PSA based Operator Support System with an emphasis on improving the effectiveness of current event based hardcopy emergency operating procedures to symptom based procedures, c) Development of risk-monitor, d) Assessment of Surveillance Test Interval and Allowable Outage Time for safety systems, e) development of root cause analysis methodology based on PSA tools, f) employment of PSA tools and technique for safety performance review of the plant.

4.2. Condition monitoring techniques have become part of routine surveillance for our research reactors. All safety critical components are being monitored with the objective of predicting the incipient failure. Currently this Programme covers the rotating machines, however, the efforts are on hand to extend this philosophy for passive components like electrical terminal / junction boxes, and similar other systems. There are good numbers of cases wherein the condition monitoring technique was able to predict the incipient bearing failures, etc. in advance and enabled advanced scheduling and better management of maintenance programme which enhanced safety and availability.

4.3. Research and development work is extensively being pursued to develop operator support system. An integrated approach has been developed by employing Artificial Neural Network for transient identification, knowledge based framework for fault diagnosis and PSA tools and methods for knowledge representation for various modules of operator support systems. The plant symptoms which are monitored on-line forms the input to the ANN module of the system. Once transient condition is identified the control passes to the diagnostic module which generates the applicable emergency operating procedure for the given plant condition.

4.4. The control technology has evolved from the first generation valve based system to relay based and currently the PLC based system. However, keeping in view the complexity of the systems and computational need there is need to develop system that are more efficient compared to PLCs. To this effect the Field Programmable Gate Array (FPGA) based systems are finding wider applications. However, these systems are still not being used in safety critical applications in nuclear industry. The main reasons which are coming in the way of employing this technology for safety critical application is a) reliability of the FPGA, b) New Failure mode that could be expected in these systems, and c) reliability of the software modules. R&D work has been initiated to have an assessment of reliability for FPGA systems keeping in view the requirements of safety. The experiments performed so far, by modeling the algorithm of a relay based system have produced encouraging results. Further, the work on development of full scope model of the control logic is being developed as part of this research.

4.5. Further work is on hand to develop a Risk Monitor based on PSA model. This tool is expected to be of immense use for routine decisions in support of operation. The current approach of taking decisions in operation is highly based on engineering judgment which is prescriptive and arbitrary in nature. The PSA model which is based on the logical and systematic model of the plant using operational performance data provides an effective framework for taking decisions.

5.0 ISSUES FOR INTERNATIONAL COOPERATION

Even though extensive R&D is being performed to address the issues with the objective of enhancing the safety and reliability of our nuclear plants, there are some areas which need attention of the member states to have participatory Programme with IAEA as the coordinating agency to address some of the issue as mentioned below:

The size of research reactors ranges from a few watts to Mega watts of power and the design varies from a pool type to tank type. The safety criteria / requirements that are applicable to small reactor like Apsara, a 1 MWth pool type reactor, may not be applicable to a reactor like Dhruva having a rated power level of 100 MWth. For instance, different sets of rule are required to determine the ISI requirements for these two types of designs. Hence, there is need to develop a graded approach which facilitates the determination of the safety requirements for different sizes / types of reactor. Probabilistic Safety Assessment framework provides an efficient framework for determining surveillance requirements, based on the likelihood of various accident sequences and their consequences.

Documentation is one of the areas that need special attention. The modern tools like ISO-9000 provide an efficient mechanism to improve organizational management in general and documentation in particular. This is important for development of safety and performance documents of the facility.

6. CONCLUSION

At BARC, we have a long history of designing and safely operating many research reactors. The technical support programme of Research Reactor Services Division is multi-disciplinary in nature. Apart from handling the problems that need design and engineering support, the existing framework provides R&D support for improving the design and operational safety of the research reactors. Our research reactors are governed by safety requirements as brought out in IAEA document DS 272. Even though the current Technical Support framework is effective in addressing issues that are on hand, keeping in view the future requirements in respect of safety, there is need to enhance this programme to cover some of the new developments like, effective utilization of PSA in determining and prioritizing various safety issues, enhancement of condition monitoring programme to cover components other than rotating machines, deployment of computer based aids for control room applications, to improve operational reliability and safety of the plants. IAEA could initiate projects in the area of development of graded framework not only for design, but for operation and maintenance of research reactors.

Conference of Radiation Control Program Directors, Inc. (CRCPD)

A Model for Networking, Cooperation, Resource Sharing, Information Exchange and Regulation Harmonization

Abstract

The focus of the talk will be to introduce the participants to the Conference of Radiation Control Program Directors, Inc. (CRCPD) and their proven methods for networking, information exchange, regulation development and standardization, and radiation protection guidance on emerging technologies. The presentation will describe how radiation control programs and staff from all 50 states in the US work collaboratively to ensure adequate radiation protection standards are uniformly applied throughout the country by pooling of resources and networking between all the states and the federal government, as well as with international members and partners. The products of CRCPD, such as the Suggested State Regulations along with other relevant informational documents, will be discussed along with how participants can access these products for use in their respective countries. CRCPD and its members represent a comprehensive radiation regulatory structure, covering all radiation sources and activities, (radioactive materials, licensing, registration, radioactive waste, x-ray, accelerators, emergency response, environmental monitoring, radon, and security). Networks are in place for all radiation issues. At the completion of this presentation, the participants will better understand a proven method to develop and implement a cooperative partnership with other countries. They will also gain knowledge on how to access CRCPD products that can be tailored for their own use and how to request technical assistance from membership

- The 50 State Radiation Control Programs in the U.S. are independent political units similar to different countries. CRCPD is an organization that provides a mechanism for these programs to share resources, information, and expertise to address the complex issues of radiation regulation. Through our working group process we provide needed products, guidance, training, and technical assistance to our members and partners. CRCPD also has formal working relationships with Federal Agencies and Organizations that

either use or regulate radiation sources or are involved in radiation protection.

Purpose

- To provide a common forum for the exchange of information among state and local radiation control programs.
- To provide a mechanism for states to communicate and work with the affiliated organizations and federal government on radiation protection issues.

Mission

- To promote consistency in addressing and resolving radiation protection issues.
- To encourage high standards of quality in radiation protection programs
- To provide leadership in radiation safety and education

What Can CRCPD Do for You

Opportunity to network with radiation protection professionals worldwide

Provide/Develop Needed Regulatory Products

Provide Training

Provide opportunities to Serve on Working Groups/Task Forces

Provide subject-matter experts

Program evaluation/consultation

Mechanism for Information Exchange and Problem-solving

Federal Agency Relationships

CRCPD, through cooperative agreements, purchase orders and various partnership programs, works very closely with the following federal agencies:

Nuclear Regulatory Commission	Environmental Protection Agency
Federal Emergency Management Agency	Dept. of Energy
Dept. of Homeland Security	Food & Drug Administration
Dept. of Transportation	Dept. of State
Centers for Disease Control	Dept. of Agriculture
National Institute of Standards	National Academy of Sciences
National Institute of Occupational Health and Safety	

International Involvement

- International Atomic Energy Agency (IAEA)
- International Council on Radiation Protection (ICRP)
- International Radiation Protection Association (IRPA)
- OECD Nuclear Energy Agency

Formalized Liaisons

Health Physics Society	American National Standards Institute
National Council on Radiation Protection	American Academy of Health Physics
Assoc. of Physicists in Medicine	Society of Radiologic Technologists
American College of Radiology	Society of Nuclear Medicine

Committee Activities

International Outreach and Relations (General Council)

- Enhance the relationships with international partners such as the IAEA (International Atomic Energy Agency), ICRP (International Council on Radiation Protection), other countries and organizations.
- Provide experts to serve on international committees, IAEA RASSIA Missions, ECT.

Suggested State Regulations (Suggested State Regulations for Control of Radiation Council)

Develops suggested state regulations for the control of radiation in the areas of radiation producing machines registration, use and inspection, and radioactive materials licensing, use and inspection.

Unwanted Radioactive Materials (Environmental Nuclear Council)

Develops a national system for the identification, characterization, packaging, management and disposition of unwanted or orphan radioactive sources.

Resource Recovery & Radioactivity (Environmental Nuclear Council)

Develops recommended response and event notification protocol when radioactivity is detected in metal and scrap, and recommends a system for reporting such incidents. Develops guidance for the disposition of contaminated scrap and guidance on the use of detectors at landfills.

Radioactive Waste Management (Environmental Nuclear Council)

Develops guidance and recommendations for states in regulating the management of low-level radioactive waste.
This guidance includes both technical and administrative recommendations for waste generated under the Atomic Energy Act and NARM.

Decontamination & Decommissioning (Environmental Nuclear Council)

Develops recommendations for residual radiation level and exposure standards for decommissioned facilities, including guidance for adequate disposal of the waste produced by decontamination activities.

Emergency Response Planning (Homeland Security and Emergency Response Council)

Develops guidance for states in planning for and responding to radiological emergencies around nuclear power plants, radiological dispersion devices, and transportation accidents. This guidance includes protective actions, protective drugs, decontamination, environmental and plume analysis. Guidance is developed for all responder classifications.

Medical Practice

(Healing Arts Council)

Recommends programs and activities for state implementation to reduce administratively applied X-rays; and provide guidance for consumer/patient education in X-rays. Committees focus on quality assurance for diagnostic X-ray, mammography, and evaluation of exposure trends.

Services of CRCPD

Provide a website to keep interested parties informed on CRCPD activities publications, and services.

Web address is www.crcpd.org

Coordinate and conduct an annual National Conference on Radiation Protection

Coordinate and conduct an annual National Radon Conference

Comprehensive radiation control program review for states

Accredit regional calibration laboratories

Provide guidance and training in all areas of radiation protection

Major Publications

Criteria for an Adequate Radiation Control Program

Profile of State Radiation Control Programs

Various technical reports relating to radiation protection

RDD Card/Handbook for First Responders

Bimonthly *Newsbrief*

Directory of Personnel Responsible for Radiological Health

Proceedings of annual national conferences

Radon Bulletin

Directory of State and Federal Agencies Involved with Transportation of Radioactive Material

Technical support of regulatory authority in Ukraine

Inyushev V., Mayboroda O., Yermakova L., Zeleny O.

State Scientific and Technical Centre on Nuclear and Radiation Safety (SSTC NRS),
Kiev, Ukraine

Abstract. Main results of 15-year SSTC NRS activity in the field of technical support of regulatory authority are presented. The article also described management policy, quality assurance system, personnel training system and international co-operation of SSTC.

1. Introduction

Ukraine is a country with well-developed nuclear energy that not only operates the existing power capacities but also possesses all the required resources to develop this area in future. Thus, in 2004 two new power units WWER-1000 have been commissioned. The strategy for development of the fuel and energy complex of Ukraine up to 2030 provides for increase of electrical energy output by power plants, this requires extension of lifetime of the operating power units and additional introduction of new generating capacities.

The balanced state policy as regards safety assurance in utilization of nuclear energy is very important in development of nuclear energy. The State Nuclear Regulatory Committee of Ukraine (SNRCU) carries out the state policy in this area. Development of the state regulation system for nuclear and radiation safety in Ukraine contributed to the effective augmentation of SSTC NRS scientific potential as an essential element of the state regulatory system that provides for its scientific-technical and expert-analytical support.

2. Objective and main tasks of SSTC NRS

The objective of SSTC NRS is to provide for comprehensive scientific-technical support of the state regulation for nuclear and radiation safety, including scientific, analytical, expert, technical, engineering, methodological, informational and advisory activity.

The following main tasks carry out SSTC NRS for achievement this objective:

- Scientific and technical substantiation of the principles, criteria and requirements in the area of nuclear and radiation safety.
- Development of guides, rules and standards in the area of nuclear and radiation safety.
- Scientific, analytical and expert support of the regulation of the activity related to utilization of nuclear energy and radiation technologies.
- Assessment of the current status of nuclear and radiation safety of the nuclear installations and radiation technologies, assessment of the risk from their utilization.
- Generalization of the experience in utilizing nuclear installations and ionizing radiation sources.
- Development of scientifically justified recommendations on the improvement of the safety level of nuclear installations and ionizing radiation sources.
- Information, analytical and expert support of the emergency response system of the state regulatory authority for nuclear and radiation safety.
- Scientific and technical support of the system of state accounting of nuclear materials and control over their storage.
- Acquisition and application of the state-of-the-art experience in the area of safety analysis and risk assessment of the operation of nuclear installations and utilization of radiation technologies.
- Preparation of the analytical and information materials on the status of nuclear and radiation safety at Ukrainian nuclear energy facilities for state regulatory authority for nuclear and radiation safety.

3. Management and planning

Management of the activity and personnel policy meet the “SSTC Direction statement on the policy as to organizational structure optimization”. Measures for the activity optimization are determined based on its routine analysis, development strategy and current planning, redistribution of functions and tasks among divisions, introduction of quality management system, scientific-technical cooperation, implementation of the personnel training and skills improvement program and development of logistic support.

SSTC NRS independently plans its activities, identifies the strategy and basic areas of its development according to scientific and technical prognosis, plans and priorities of the SNRCU, programs of international scientific and technical cooperation in nuclear safety based on agreements implemented by the SNRCU, service market environment and economic situation.

SSTC NRS R&D and business activities are planned annually through development of the Comprehensive Activity Plan and Financial Plan.

The SSTC NRS Comprehensive Activity Plan consists of the following elements:

- Section 1 SSTC NRS Subject Research and Development Plan;
- Section 2 Plan of Organizational and Technical Measures;
- Section 3 Plan of SSTC NRS Personnel Training;
- Section 4 Plan of Social and Cultural Measures;
- Section 5 Costs of SSTC NRS Activities by Sections.

4. Quality assurance system

Quality assurance system has been implemented in SSTC NRS based on principles of the state standard DSTU ISO 9001-2001.

SSTC NRS performs consistent policy as regards quality assurance of work and services in order to achieve the following results:

- Forming of a positive attitude of Ukrainian and international community to the status of nuclear and radiation safety due to appropriate quality of state regulation;
- Keeping of the requirements of legislation, standards, rules and regulations on nuclear and radiation safety;
- Improvement of the activity by making the most efficient use of manpower, financial, and material recourses.

5. Expert support of SNRCU in licensing activity

One of the reasons for accepting the decision by the regulatory authority on issuing or refusing in a license or individual permit is the conclusion of the state expert review on nuclear and radiation safety – a comprehensive safety assessment considering all the factors causing nuclear and radiation hazard for human health and the environment.

The review system, which unifies issues on development of regulatory and methodological basis and permanent personnel training, assistance and improvement of his qualification, assurance of adequate quality of reviews, has been implemented in SSTC NRS and is constantly being improved.

Methodological framework is based on quality management system regulations; the most important methodologies of expert review have been implemented by the SNRCU as branch regulatory documents. Information assurance is performed through the existing data bases that function within the unified information system.

Calculation and analytical assurance of the expert activity includes more than 50 software tools. Activities related to acquirement of up-to-date models and computer codes are carried out over the whole period of SSTC NRS existence.

Yearly, SSTC NRS expert activity makes up to 60% of the total scientific-technical activities. Within the period of its existence, SSTC NRS carried out more than 4000 state expert reviews, including reviews in frames of international projects.

In the last years there were the following main aspects of reviews:

- Safety analysis reports of operating NPPs, including technical safety justifications, probabilistic safety analyses, analyses of design basis accidents, additional safety analyses etc. and safety analysis report for commissioning NPPs – Rivne-4 and Khmelnytsky-2;
- Modernization programs and safety improvement measures;
- Documents of the Shelter Implementation Plan (SIP);
- Safety substantiation of radioactive waste and spent nuclear fuel management facilities etc.

6. Expert support of SNRCU in supervision activity

SSTC NRS technical support of SNRCU in **supervision** activity deals with the following issues:

- Identification of methodological approaches to target inspections;
- Development of inspection procedures;
- Analytical research in acquirement and introduction of the advanced experience;
- Common inspections, analysis of the received results and the development of correcting measures.

A special attention has been paid to scientific-technical support of inspection activity at Khmelnytsky-2 and Rivne-4 commissioning stage and in SIP implementation. This was conditioned by the necessity to specify operability and safe operation of equipment and buildings that were conserved for a long time at the mentioned power units, as well as by uniqueness of the Shelter and measures to be implemented under string radiation impact.

The experience acquired in inspection activity at the units commissioning stage, analysis of relative regulatory documents of Ukraine, Federal Supervision of Russia, NRC (USA), and IAEA recommendations constitute a basis for developing a draft regulatory document “Requirements for composition and content of inspection programs and plans at stages of Ukrainian NPPs units commissioning”, as well as inspection programs and plans regarding preparedness of systems and equipment for pre-commissioning activities, physical and power startup, emergency readiness and radiation safety assurance, quality system and personnel qualification.

7. Regulatory acts development

Provisions of regulatory acts on nuclear and radiation safety are harmonized with relative standards of EU and conditions for their application are determined in accordance with the Law of Ukraine “On national program for adaptation of the Ukrainian legislation to the legislation of the European Union”.

There are the following regulation subjects in the area of utilization of nuclear energy:

- Safety goals and principles;
- Qualitative and quantitative criteria and indicators;
- Distribution of functions, and procedures for interaction of legal relationship;
- Technical requirements on RF safety equipment and systems as well as facilities for radioactive waste Management and other ionizing radiation sources;
- Management of activities on safety assurance.

SSTC NRS regulatory effort constitutes 66 regulatory acts, 29 of these documents are referred to the category “Standards and rules” and have been certified by the Ministry of justice of Ukraine.

8. Research and development activity in SSTC NRC

SSTC NRS R&D work is intended to discover, identify and determine ways to solve problems regarding regulation and safety assurance. Research of this area is intended to analyze:

- Design, operation procedures and practice, safety deficit;
- Strength and reliability of the main equipment, reactor vessel and the confinement, functional sufficiency and reliability of safety related systems, including information and control systems etc;
- Failures and violations in NNPs operation and reasons and consequences of failures and damages of equipment, systems and elements;
- Emergency events and their consequences.

SSTC NRS scientific effort is aimed at carrying out of exploratory researches of different facilities that apply nuclear and radiation technologies in order to obtain and implement new knowledge in nuclear and radiation safety.

SSTC NRS is a creator a periodical issue – Journal “Nuclear and Radiation Safety” registered at Supreme Commission of Ukraine as a profile scientific edition on technical-physics and mathematics sciences. Annotations of articles, published in the journal, are regularly allocated at IAEA’s scientific publications data base INIS (International Nuclear Information System).

During last three years the 5 monograph by employees of SSTC NRS were published [1-5].

9. International co-operation of SSTC NRC

SSTC NRS participates in international technical cooperation projects based on programs implemented by the SNRCU in the framework of international technical assistance provided by other states according to:

- The Framework Agreement between Ukraine and the European Bank for Reconstruction and Development regarding the Chernobyl Shelter Fund in the framework of the Grant Agreement (Chernobyl Shelter Fund Project Licensing Consultant);
- The Agreement on Partnership and Cooperation between Ukraine and European Communities and Their Member States; EC Council Regulation No. 99/2000 of 29 December 1999 regarding assistance to partner states from Eastern Europe and Middle Asia (TACIS Program);
- Agreement between the Government of Ukraine and the Government of the United States regarding Humanitarian and Technical Economic Cooperation” dated 7 May 1992 (known also as the "Lisbon Initiative on Nuclear Safety");
- Agreement between the Government of Ukraine and the Government of the United States on operational safety enhancement, decreasing risk of operation and strengthening the system of regulation of civil nuclear installations in Ukraine".

In addition, SSTC NRS participates in the “Framework Program of Technical Cooperation with the IAEA”, “Program of Scientific and Technical Cooperation between German BMU/GRS and Ukrainian SNRCU/SSTC NRS”.

REFERENCES

- [1] M. Yastrebenetsky, V. Vasilchenko, M. Vinogradskaya, S. Goldrin, Yu. Rosen, L. Spector, V. Kharchenko, Safety on Nuclear Plants: Informational and Control Systems, Technique, Kiev, 2004 (in Russian)
- [2] A. Nosovsky, V. Vasilchenko, A. Kluchnikov, O. Yashchenko, Decommissioning of Nuclear Power Plants, Polytechnic, Kiev, 2005 (in Russian)
- [3] A. Nosovsky, Safety of Vital Activity, Polytechnic, Kiev, 2005 (in Russian)
- [4] A. Nosovsky, V. Vasilchenko, A. Kluchnikov, B. Prister, Chernobyl Accident: Overcoming Experience, Lessons Learnt, Technique, Kiev, 2006
- [5] A. Nosovsky, V. Vasilchenko, A. Pavlenko, E. Pismenny, S. Shirokov, Introduction in Safety of Nuclear Technologies, Polytechnic, Kiev, 2006 (in Russian).

TECHNICAL SUPPORT ORGANIZATION OF NATIONAL REGULATORS: CHALLENGES AND STRATEGY

Shahid A. Mallick, Naveed Maqbul, Samina Kanwal and Jamshed Azim Hashmi
Pakistan Nuclear Regulatory Authority, P.O. Box 1912, Islamabad Pakistan

Abstract

Design, construction and operation of nuclear power plants has always been a complex activity and so is regulating the nuclear power plants. The rapid innovation in design of nuclear power plants with substantial increase in design life from 40 years to 60 years is now considered a norm. The public acceptability of nuclear as a clean source of energy is also on the increase but with this increase is also the demand for more safety against accidental release of radioactivity. It is therefore essential that high standards of nuclear and radiation safety should be maintained and applied all over the world. However the increase acceptability will also lead to a rapid growth in nuclear energy generation capacity both in terms of construction of new nuclear power plants as well as life extension of older nuclear power plants. This will result in an unprecedented pressure on the national regulators during the licensing process. Nuclear and radiation safety are based on technical, administrative and organizational provisions. There is, therefore, a need to separate the technical review & assessment work from the main licensing process by delegating this responsibility to the technical support organizations so that regulatory decision making is not driven by the time constraints imposed by the licensing process. The paper examines the role technical support organization can play to enhance quality of technical review and thereby the effectiveness of national regulators. For the national regulators that belong to countries that import nuclear power plants and may lack an advanced industrial infrastructure at par with other exporting countries, the establishment of technical support organization within a regulatory body or as a separate organization is gaining increased importance. Pakistan Nuclear Regulatory Authority (PNRA) has realized this importance and proposed the Government of Pakistan for allocation of Rs. 480.00 million (\$ 8 million) for the establishment of technical support organization called the "Centre for Nuclear Safety" within PNRA to meet the future regulatory challenges. This paper discusses the objectives and organization of Centre for Nuclear Safety and the challenges that the centre is facing as the strategy being devised to meet those challenges. The paper includes a brief description of co-operation under an IAEA TC project titled "Further Improvement of Nuclear Regulatory Infrastructure in Pakistan-(PAK/9/28)" which is an example of international co-operation in the establishment of technical support organization to enhance the regulatory effectiveness of the national regulator in Pakistan.

1. INTRODUCTION

The Chinese regulatory authority called the National Nuclear Safety Administration (NNSA) very early has established a technical support organization called the Nuclear Safety Center (NSC) – Beijing delegating it the task of supporting regulatory decision making by performing review and assessment work. Both the French regulatory bodies; DSIN (Directorate for Nuclear Installations Safety) and OPRI (Board for Protection against Ionizing Radiation) had independent expert institution called IPSN. In early 2002, a new regulatory authority DGSNR (General Directorate for Nuclear Safety and Radioprotection) was established as a result of merger of DSIN and OPRI. At the same time a new expert institution, the IRSN (Institute for radio-protection and nuclear safety) combining IPSN and OPRI was also formed. This was the time when nuclear industry was going through a period of unprecedented change because of de-regulation, re-structuring and loss of competence and research capabilities on one hand and the increase demand of nuclear generating capacity on the other hand, more and more regulatory bodies were opting for technical support organization either as a part of regulatory body or in many cases as separate organization.

Pakistan Nuclear Regulatory Authority (PNRA) as an independent nuclear regulatory authority had recently been established in Pakistan on 22nd January 2001. PNRA was

watching these developments carefully. PNRA invited the International Regulatory Review Team (IRRT) in December 2003. The IRRT mission reviewed the regulatory framework of Pakistan based on IAEA Safety Standards Series “Legal and Governmental Infrastructure for Nuclear, Radiation, radioactive Waste and Transport Safety – GS-R-1”. One of the recommendations that it gave was the establishment of an independent technical support organization. Taking consideration of the changing environment of nuclear industry as well as the development in regulatory bodies of other countries to meet the challenges arising from these changes, PNRA also started contemplating establishing an expert institute on the pattern of Nuclear Safety Centre (NSC)-Beijing or Institute for Radioprotection and Nuclear Safety (IPSN) – France. A proposal was submitted to the Government of Pakistan for establishing a technical support organization called the “centre for Nuclear Safety (CNS)” within PNRA in June 2004. The Government of Pakistan has approved the proposal and allocated an amount of Rs. 480.0 million for the establishment of CNS in December 2004. Centre for Nuclear Safety is now being established with the objective of performing review and assessment for nuclear power plants in Pakistan as delegated by PNRA. It will be ensured that regulatory body maintains responsibility for licensing of nuclear power plants while CNS provide support to PNRA in licensing decision making.

2. OBJECTIVE AND ORGANIZATION OF CENTRE FOR NUCLEAR SAFETY

The main objective of Centre for Nuclear Safety is to separate the review and assessment work from the regulatory headquarter organization so that technical review can be performed with undue hindrance from the licensing process. This separation also results in reducing the potential conflict of interest which may arise if the same sets of people are involved in technical review and assessment as well as in the decision making for grant of license to nuclear power plants. Since TSOs do not make safety decisions so strict mechanism are being developed so that Centre for Nuclear Safety is only responsible for the task delegated to it by the Pakistan Nuclear Regulatory Authority. Its main function is to provide technical support in safety review and regulatory decision making to Pakistan Nuclear Regulatory Authority. The detailed objectives of CNS comprises of the following major components;

- a) Improving the skills and knowledge of the regulatory personnel through improving academic qualifications, specialized training at local and foreign institutions, on-the-job-training, exchange visits to other nuclear regulatory bodies, participation in seminars, conferences in the country and elsewhere, participation in research projects and activities within Pakistan or outside, development of competency in Chinese language etc.
- b) Recruitment and training of young engineers and scientist for strengthening the existing manpower and to replace ageing manpower.
- c) Procurement of software and perform confirmatory and audit calculations for design basis accidents, beyond design basis accident analysis, probabilistic safety analysis, seismic analysis, structural analysis, computational fluid dynamics etc. and computer systems and related accessories to verify safety cases prepared by the licensees.
- d) Initiate safety Research and Development activities in different areas of safety analysis
- e) Developing strong documentation base and information centre equipped with regulatory documents (such as regulatory guides, review plans, safety reports formats, etc.) from countries such as USA, UK, Germany, France, China, Republic of Korea etc. and international organizations such as IAEA. Industrial standards such as ASME, IEEE, ANSI, ISO, IEC, DIN, BSS etc. are also needed for regulatory decision making.

- f) Developing and strengthening bilateral links with nuclear regulatory bodies of USA, China, etc. and international organizations e.g. IAEA, NEA etc.

Initially Centre for Nuclear Safety is being delegated the task of technical review and assessment, however, the organization as it is planned will also be able to support the regulatory body in preparation of regulation and inspections. It is to be noted that neither Centre for Nuclear Safety will approve regulation nor its staff will perform regulatory inspections. It will only support the regulatory body in both preparation of regulation and conduct of inspections.

3. CENTRE FOR NUCLEAR SAFETY: CHALLENGES AND STRATEGY

The biggest challenge that the centre is facing is regarding the acceptance of its functions and scope of work within the regulatory body. The core functions of regulatory body include review and assessment, Inspection and Enforcement, authorization and development of regulations. At present, the review and assessment function has been separated from the licensing arm of PNRA and the responsibility is delegated to the TSO. The main stream group of reviewers are finding it difficult to understand the paradigm shift in function of licensing and review & assessment. Since they have been performing both the tasks for quite sometime, so it is difficult for them to understand that there is a possibility of potential conflict of interest if the same group performs review & assessment work as well as authorizes the license.

The other challenge that the CNS is facing is regarding the extent to which an audit calculations should be performed. There are two predominant views in the regulatory body, one group of experts believe that regulatory body should not perform audit calculations to the extent that it starts repeating the licensee submittal while the other groups of experts thinks that the regulators should repeat most of the analytical calculations that are submitted by the licensee. Between these two extreme there is a small group which is of the opinion that selective audit calculations should be done. This leads to a bigger challenge for the technical support organization in terms of developing competency. Which ever view is taken the competency requirement for TSO will be different for these three varying approaches.

CNS believes that performing limited scope but thorough audit calculations is essential to verify licensee submittal in selected areas of interest. CNS has started acquiring tools as well as knowledge and skills in selected areas to address this challenge. On the immediate basis CNS is building competency of deterministic safety analysis in areas of design basis accident, beyond design basis accident, stress and seismic analysis. and probabilistic safety analysis.

Centre for Nuclear Safety per se is a newly established technical support organization within Pakistan Nuclear Regulatory Authority. It has inducted thirty five new staff most of them have just completed their engineering degree. Induction of such a large number of people in a relatively smaller organization poses huge challenge not only in terms of training and capacity building but also regarding their assimilation in the organization. A well structured training as well as placement programme is in place. The placement and rotational programme within various directorates of PNRA helps in assimilation of new staff within the organization.

In terms of training and capacity building the time constraint for review of FSAR for Chashma Nuclear Power Plant Unit-2 (C-2) is quite tight. C-2 FSAR is expected to be submitted in August 2009. Similarly the first periodic safety review of Chashma Nuclear power Plant Unit-1 (C-1) is expected in the year 2009 as well. Centre for Nuclear Safety should be well prepared with highly trained and competent staff to undertake the challenging tasks of review and assessment of FSAR for C-2 as well as PSR for C-1. As a part of

strategy, all the new staff of CNS is required to perform a mock review of C-2 PSAR to provide a real hand on experience of review and assessment work.

Lastly, CNS is established to meet the need for review and assessment of future nuclear power plants in Pakistan, so the newly recruited staff of the centre is not involved in current review and assessment work. CNS staff is being used for joint technical study of pre-PSAR of 600 MWE PWR that is expected to be constructed in Karachi.

4. ROLE OF INTERNATIONAL ORGANIZATION IN DEVELOPMENT OF CENTRE FOR NUCLEAR SAFETY

Pakistan Nuclear Regulatory Authority (PNRA) was established in 2001 as an independent body to regulate the country's nuclear program and radioactive installations. One of the key challenges faces by PNRA was in the area of Human Resource Development, particularly with respect to attracting, retaining and developing its staff members, and building required competencies in the organization. A project partially funded by the International Atomic Energy Agency (IAEA) was initiated to address the key challenges faced by PNRA

An organizational review of the PNRA was conducted based on interviews of the senior management and review of documents of PNRA, International Atomic Energy Agency (IAEA) and regulatory bodies of other countries. The major strengths of PNRA were identified as follows:

- Independent Statutory Body
- Technically Qualified Manpower
- Open Organizational Culture
- Stable Funding Resource
- Strong Relationship with IAEA

However, during the organizational review, several areas of improvement were also observed. It was observed that PNRA will need to pay special attention to the following areas which are being termed as weaknesses of the organization:

- Lack of HRD System
- Low Public Awareness
- Lack of Legal Expertise
- Weak Relationship with External Stakeholders and Clients
- No Technical Support Centers
- Testing Equipment and Labs Not Up to International Standards
- Management Information System (MIS) Not Integrated Across the Entire Organization.
- Lack of Strategic Planning Process

The need to establish Technical Support Organization therefore was identified during the systematic organizational review conducted by the International Regulatory Review Team (IRRT), partially funded by IAEA-TC project "PAK/9/023- Strengthening of Nuclear Regulatory Authority in Pakistan". The Centre for Nuclear Safety was then initially established through the second IAEA Technical Project "PAK/9/028-Further Improvement of Nuclear Regulatory Infrastructure in Pakistan" in early 2002.

PNRA has completed six years of its inception. During these six years IAEA assistance in form of TC-project has been extremely useful in establishing its basic regulatory

infrastructure. It is because of the TC-project that Centre for Nuclear Safety was initially established and then the Government of Pakistan gave substantial grant for further improvement and sustainability. This is an excellent model of idea development and initial support from international organizations and the government of developing country sharing further improvement and sustainability.

In future, it is desirable that the IAEA with the help of Member States provide guidance for a legitimate setup of Technical Support Organization in the next Revision of GSR-1 for enabling a formation of an effective TSO within the regulatory framework in Pakistan.

5. CONCLUSION AND FURTHER SUGGESTED ACTIONS

Role of regulatory body is evolving. Regulatory requirement of different countries vary according to their Nuclear power program. In the path of formation of CNS, following are the major concerns:

One of CNS's major concerns is to decide how much depth in performing audit calculations to support review and assessment process is important. It is desirable to understand the scope and extent of safety analysis required to be performed. CNS has started developing expertise in fields which include PSA, DBA and Beyond DBA Accident Analysis, Neutronics and thermalhydraulic and Structural and seismic analysis. In PSA there has been a controversy about how much knowledge CNS should acquire; one group believes that CNS should be able to make its own regulatory model which would provide a basis for risk informed regulatory decision making in future while the other believe that knowledge to perform PSA review and limited audit calculations is sufficient. Similarly in case of Structural analysis it needs to be decided whether the group should have the full capability to verify all the licensee's calculations by performing analysis of their own or spot check the results of analysis performed by the licensee.

Another challenge CNS faces is the legitimacy of work and recognition of responsibility of CNS. It needs acceptance from within the regulatory body because authorization team itself is confused about role of CNS and fears that it will grab their work.

Another concern of the main reviewers is whether CNS should also handle development of regulations and Emergency preparedness or not. Both of these tasks require special attention and experienced workers who are dedicated to these tasks.